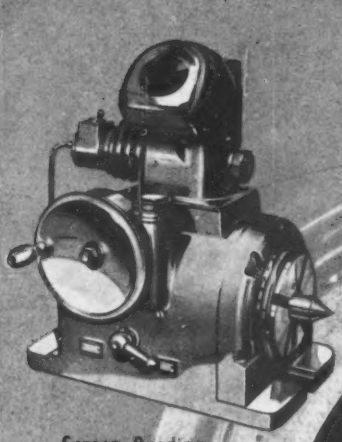
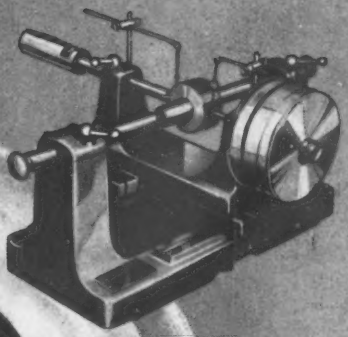
# MACHINERY

AUGUST 20, 1958 ONE SHILLING & THREEPENCE

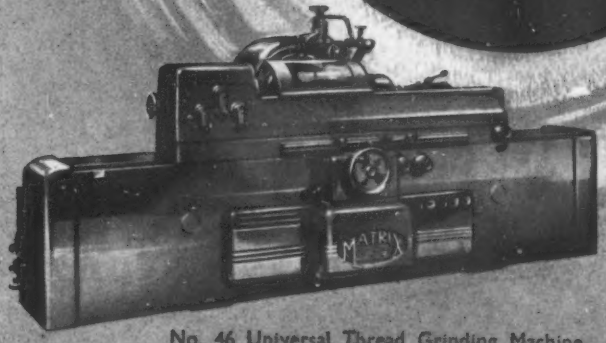



Screen Reading
Optical Dividing Head



Floating Carriage
Diameter Measuring Machine

*Supreme the World over*



No. 46 Universal Thread Grinding Machine

No. 61 Gear Grinding Machine

the authority on

SPECIALISED MACHINE TOOLS
PRECISION MEASURING INSTRUMENTS & GAUGES
PRECISION ENGINEERING EQUIPMENT

**Coventry Gauge**

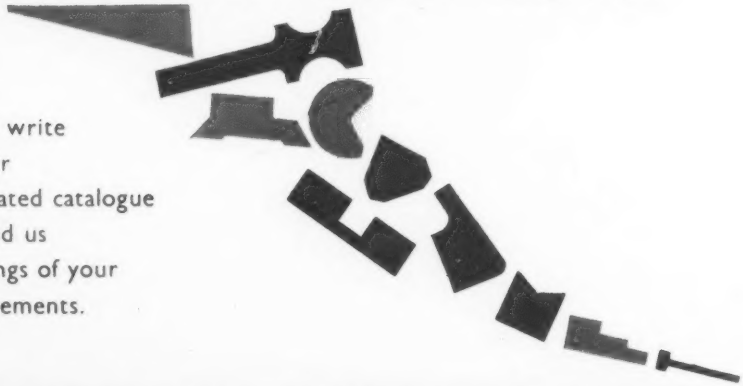
& TOOL COMPANY LTD

P.O. BOX 13, COVENTRY, ENGLAND

Mills Bright Drawn Special Sections eliminate the need for machining from the solid, have a bright, smooth finish and are accurate in detail and to required limits. Produced in Mild and Medium Carbon Steels, Free-cutting and Case-hardening Steels, Heat Treated or Alloy Steels and in equivalent Mills "Ledloy" Steels.

# MILLS

## *BRIGHT steel special sections*



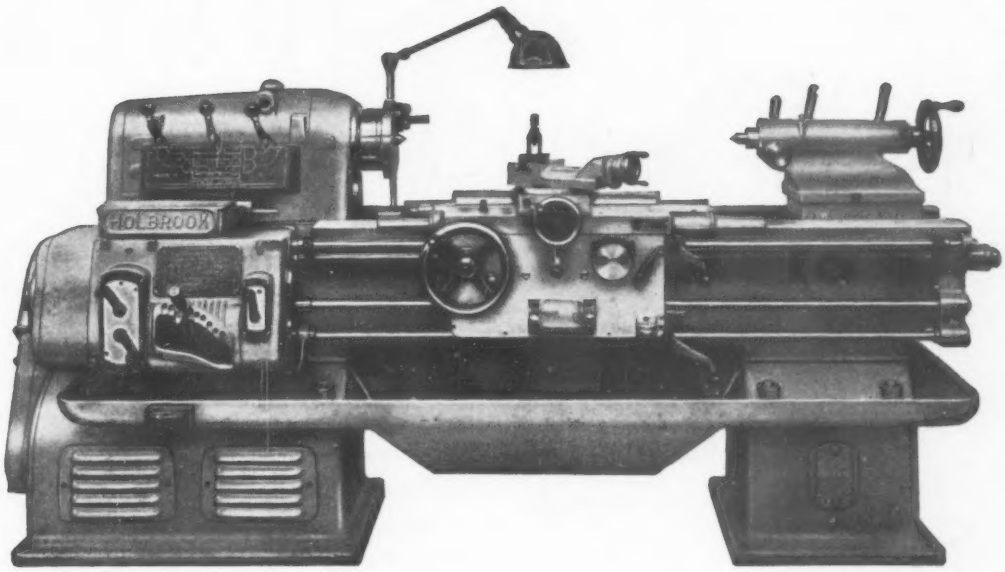
Please write for our illustrated catalogue or send us drawings of your requirements.

**BREDBURY STEEL WORKS**
**WOODLEY. NR. STOCKPORT**

Telephone: WOODLEY 2231.(10 lines) Telegrams: "MILLS" PHONE WOODLEY

# Holbrook

**STRATFORD LONDON ENGLAND**




## MODEL "B"

## PRECISION TOOL-ROOM LATHES

Built in 3 Sizes
Swinging 13-17-21 inches over Bedways

Cam-lock Spindle Nose
Synchronizing-Reversing-Clutch for Threading and Feeds - Precision Lead-Screw with Compensating End Thrust - Enclosed Apron with Finger Tip Control for Feeds
Electric Suds Pump

*The Finest Lathe in its Class*

AVAILABLE WITH FULL ADDITIONAL EQUIPMENT

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A

# NEW GAUGES FOR OLD

For some time arrangements have existed with some of our larger customers to replace old and worn dial gauges at a fixed allowance of ten shillings per gauge. This is now being extended for a limited period only to any firm in the British Isles, and there must be many who would gladly exchange their old dial gauges on the same terms for new and up-to-date models.

All you have to do is to send your old dial gauges to your usual merchant, or in case of difficulty to us direct, and a new replacement of the type you require will be promptly despatched.

Catalogue on request—

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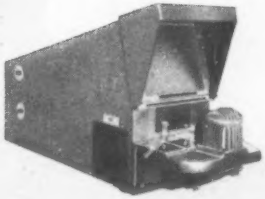

*measurement by projection with*

# HILGER

**Inspection Enlargers**

Simple projectors for checking form and dimensions of small components against enlarged layouts. Thread forms can also be checked against templates.
Mag. from X 10 to X 500.

**Production Projectors**

Similar to Inspection Enlargers, but designed for use in the horizontal position so that the operator can be seated for rapid checking, without fatigue, of mass-produced components.

**Universal Projectors**

Combine the advantages of ordinary projection with the addition of micrometer measuring equipment reading to 0.0001in. Co-ordinate measurements to 0.0001in. and angular measurements to 1 minute can be made.

Largest instrument will accommodate work up to 50 lbs. in weight, projector screen being 20in. dia. and measuring range 7in. horizontally and 2½in. vertically.

*Send for illustrated catalogue "Hilger projectors for production."*

AD 425

ALFRED HERBERT LTD., COVENTRY

# STEEL STAMPINGS LTD

**use**

## HARPER MEEHANITE CAST-TO-FORM TOOLS

**for their high grade presswork**

1 Produced from 8 S.W.G. Stainless Steel.

2 Produced from 15/32" Mild Steel. Pressed cold in tools fitted with Harper Meehanite Inserts. 28,000 pressings have been produced without any tool reconditioning.

3 Produced from 18 S.W.G. Stainless Steel. 9,800 pressings made without any tool reconditioning.

4 Produced from 14 S.W.G. Mild Steel. 10,700 pressings produced; tools only reconditioned once.

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*Harper quality covers grey iron, ductile iron and Meehanite castings, also metal pressings and other finishes and sub-assembly work.*

# HARPER CASTINGS

CASTINGS WITH THE HARPER SKIN

**JOHN HARPER & CO. LTD. JOHN HARPER** (MEEHANITE) **LTD.**

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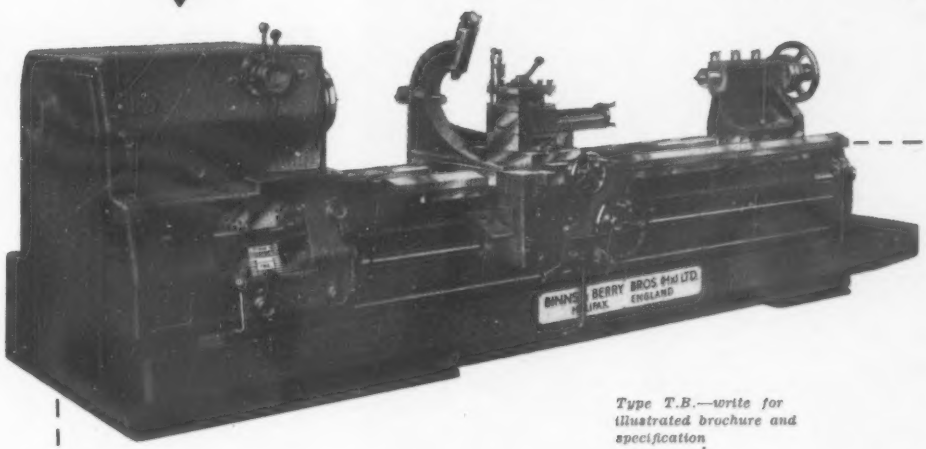
MANCHESTER OFFICE: c/o G. J. Brown & Partners Ltd. 248/9 Royal Exchange, Manchester 3

EH20

# 12½" CENTRE LATHE

## *Wide Capacity*




*Type T.B.—write for illustrated brochure and specification*

## *High Speed*

- ★ 16 spindle speeds from 12 to 600 r.p.m.
- ★ Independent electric power traverse to saddle and tailstock
- ★ Spindle admits 4in. diameter bars.
- ★ 15 h.p. main drive motor.
- ★ 60 change feed and screw-cutting gearbox.
- ★ Sliding feeds from 0.002in. to 0.154in per rev.
- ★ Threads from 1-56 T.P.I.
- ★ Surfacing feeds from 0.001in. to 0.100in. per rev.
- ★ Deep tray and electric suds pump.
- ★ Gap capacity 43in. diameter.
- ★ Diagonally braced bed with chilled sloping angle slideways.
- ★ Longer beds to 22ft. and full range of accessories available.
- ★ Machine delivered fully wired, piped and complete with fuses.

**You are cordially invited to visit our works at Brighouse, Yorkshire, to view these machines during construction and under test.**

## BINNS & BERRY BROS (HALIFAX) LTD

**OVENDEN · HALIFAX · ENGLAND**

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# NEW "ARO-BROOMWADE" SPRING BALANCERS

Capacity 5 lb.

Capacity 10 lb.

## *SAVE YOU TIME — SAVE YOU MONEY!*

Work is far easier and quicker with the new " ARO-BROOMWADE " Spring Balancers. Light and compact, efficient and economical, they save wear on tools and air hose or cable . . . hold tools at just the right height . . . reduce waste motion and operator fatigue to the minimum.

*Write* **now** *for full details.*

**Consider these advantages:**

- **Low cost**
- **In-line suspension of tool — no twisting or turning of cable**
- **Quick, easy adjustment of spring tension**
- **Long - life, nylon - covered steel cable**
- **Two models — 5 lb. and 10 lb. capacity**

## "BROOMWADE"

**AIR COMPRESSORS AND PNEUMATIC TOOLS**

**Your Best Investment**

**BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND**

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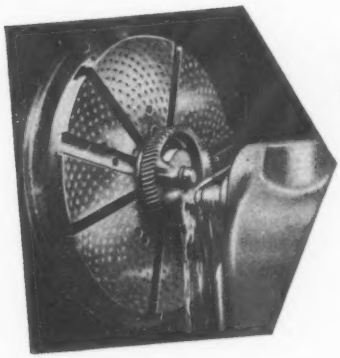


# *Entirely NEW Development*

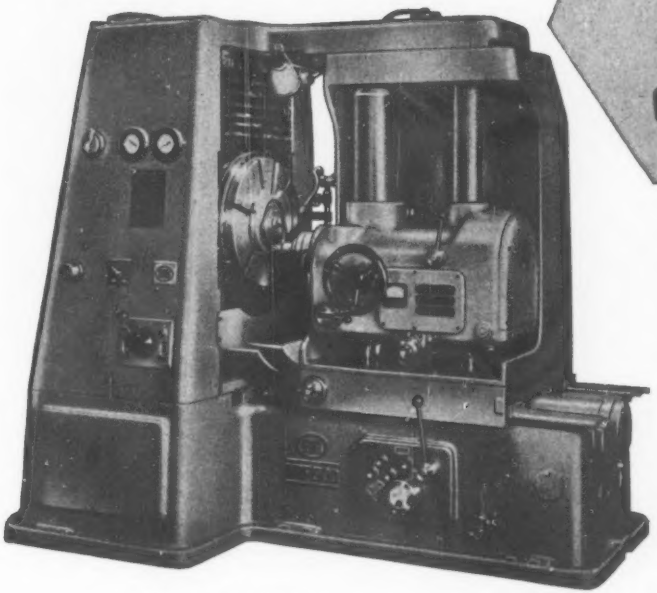
## in MACHINE CONSTRUCTION for CAM MILLING

**SIG**

**CAM MILLER**

SWISS BUILT

**Type HRF 500**



**HYDRAULIC COPYING FROM SIMPLE TEMPLATE**

**PLANETRY GRINDING SPINDLE**

**AUTOMATIC FEED REGULATION**

**SWINGING LEVER COMPENSATION**

**Note** the rigid construction which imparts a high degree of finish and accuracy coupled with high production rates.

***Send for detailed Catalogue***

***Technical Data***

| | |
|---|---|
| Face plate diameter ... ... ... ... ... | 500 mm (19½") |
| Maximum milling diameter for plate cams | 600 mm (23⅝") |
| Maximum milling diameter for cylindrical cams (Standard) ... | 260 mm (10¼") |
| (Special) ... ... | 350 mm (13⅜") |
| Maximum height of cylindrical cams ... | 300 mm (11⅞") |
| Maximum milling diameter for plate milling | 750 mm (29½") |
| Central hole in the face plate, diameter | 100 mm (3·937") |
| Milling spindle bore ISA taper ... ... ... ... ... | 13" |

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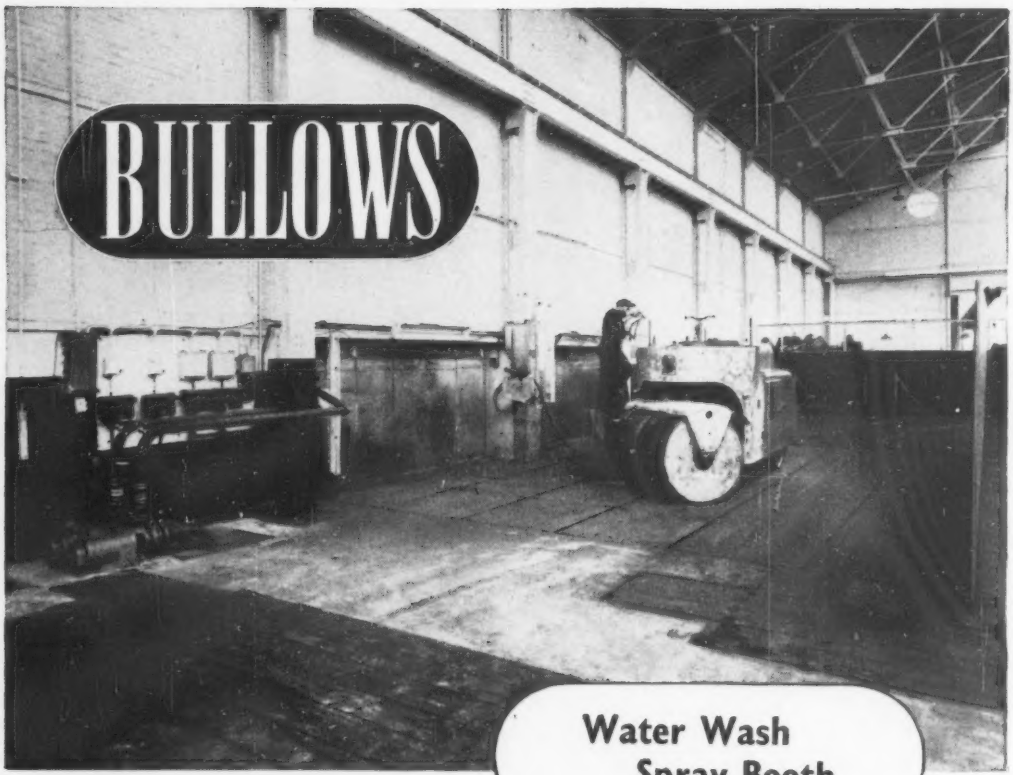


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— typical of the many BULLOWS Spray Booths installed in well-known Industrial Plants throughout the country. The results of our long experience are at your disposal. Consulting us incurs no obligation.

**SPRAY PAINTING EQUIPMENT · AIR COMPRESSORS**

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# COLD HOBBING PRESSES

BY SACK & KIESSELBACH

SEVERAL SIZES from 100—3,000 TONS CAPACITY
MASSIVE CAST STEEL BODY
PATENT SWIVELLING CLEAR-VIEW GUARD
CAN BE USED with DEPTH or PRESSURE LIMITING DEVICE
BUILT FOR THE JOB

Note depth measuring device, automatically stopping machine when required depth has been reached.

SACK & KIESSELBACH have for many years been building Cold Hobbing Presses. These machines are therefore not adaptations but are designed and built for this work only. Their sound, robust basic design, high quality workmanship plus several special features found only on these machines greatly facilitates the production of sound moulds. Further details on request.

**ROCKWELL**
MACHINE TOOL CO. LTD.

WELSH HARP, EDGWARE ROAD, LONDON, N.W.2. TEL: GLADSTONE 0033

ALSO AT BIRMINGHAM-TELEPHONE SPRINGFIELD 1134/5 · STOCKPORT-TELEPHONE STOCKPORT 5241 · GLASGOW-TELEPHONE MERRYLEE 2822

SK1

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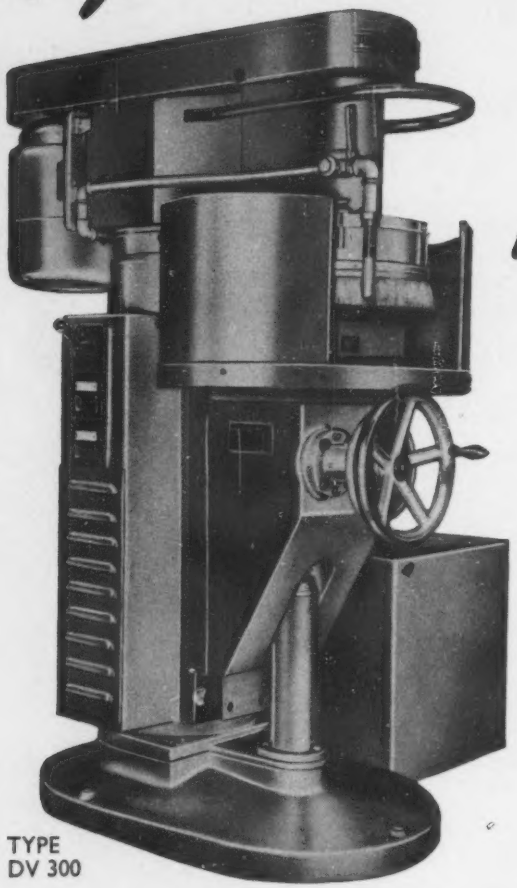
# *High Speed* STOCK REMOVAL

# DISKUS

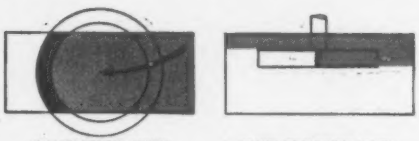
## SWIVEL HEAD SURFACE GRINDER



TYPE
DV 300

### *ENTIRE WORKPIECE SURFACE GROUND IN ONE WORKPASS*

The superior stock removal capacity of the segmental grinding wheel shortens grinding time to a fraction of that taken by peripheral grinding owing to the small area of contact with the workpiece.



ONE TRAVERSE WITH DISKUS GRINDER

MANY TRAVERSES WITH PERIPHERAL GRINDING

Balanced swivel arm, mounted on heavy duty anti-friction bearings fitted to amply dimensioned column, ensures smooth and easy movement.

**BRIEF SPECIFICATION—TYPE DV 300**

Diameter of Segmental grinding wheel 12"
Chucking surface of work table 16" x 8"
Vertical adjustment handwheel graduated in ·0002"

## Low Cost—Early Delivery

*This machine is only one of the many different models of the standard and special segmental wheel grinders made by the Diskus Company.*

**Sole Agents**

**ROCKWELL** MACHINE TOOL CO. LTD.

**WELSH HARP, EDGWARE RD., LONDON, N.W.2. TEL: GLADSTONE 0033**

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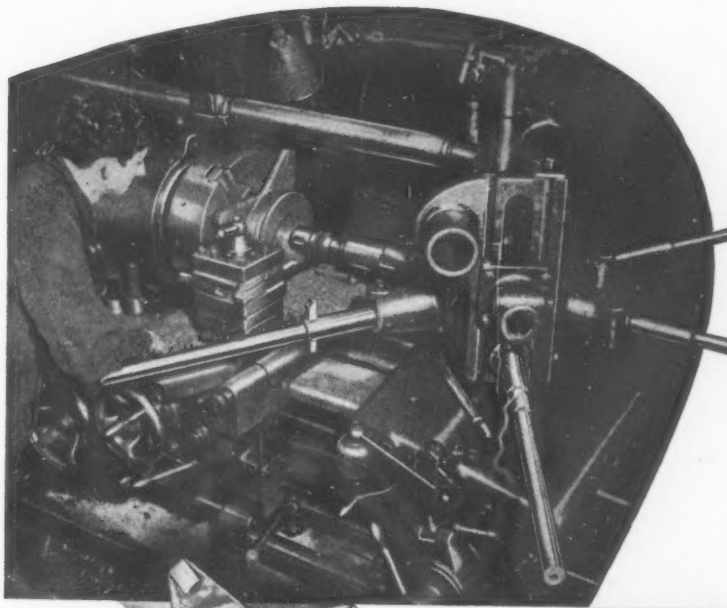
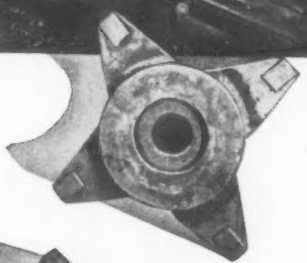
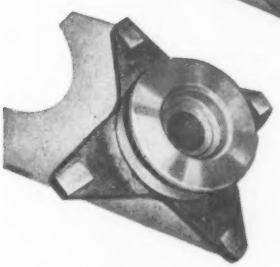
DV 300



# FOR MAXIMUM PRODUCTION

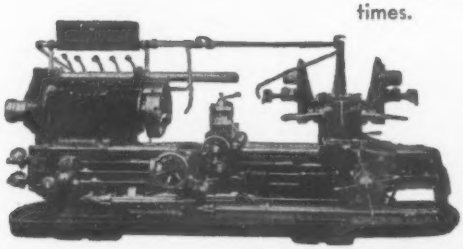




**Ward**

# COMBINATION TURRET LATHES

Reproduced by courtesy of R. H. Neal Ltd., Grantham, these photographs show a Ward No. 10 Combination Turret Lathe and the Neal crane link housing produced on it. This machine carries out 17 operations at exceptionally short floor-to-floor times.



Our complete range includes Capstan and Turret Lathes with capacities up to 35 in. swing over bed and 8½ in. diameter hole through spindle.

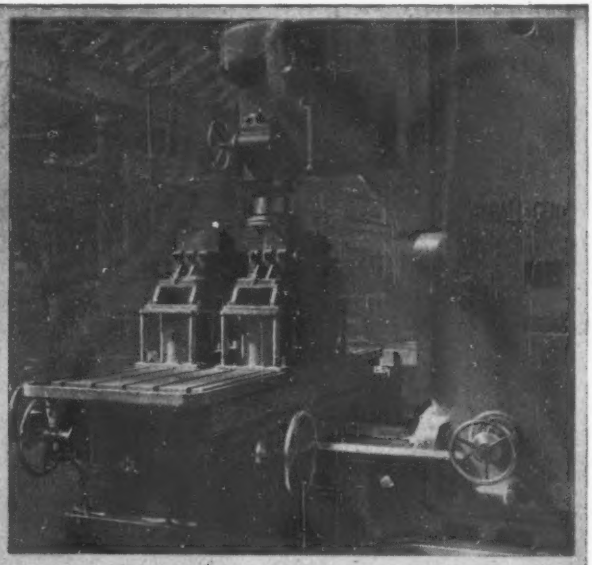
Please write for details.

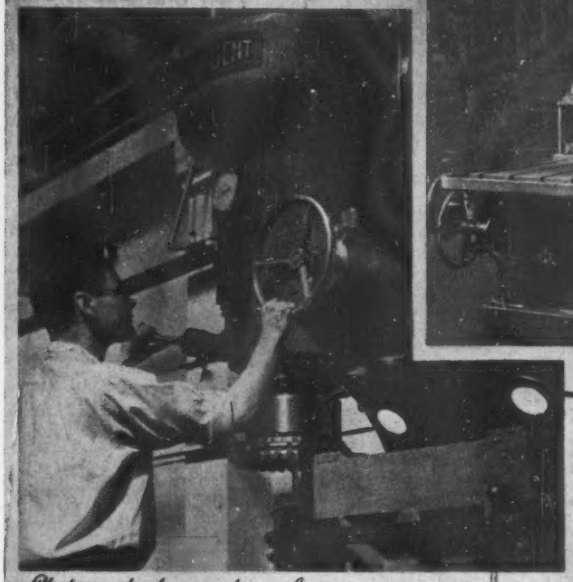
## H. W. WARD & CO., LTD.

**SELLY OAK, BIRMINGHAM, 29.** **TELEPHONE: SELLY OAK 1131**

W.613

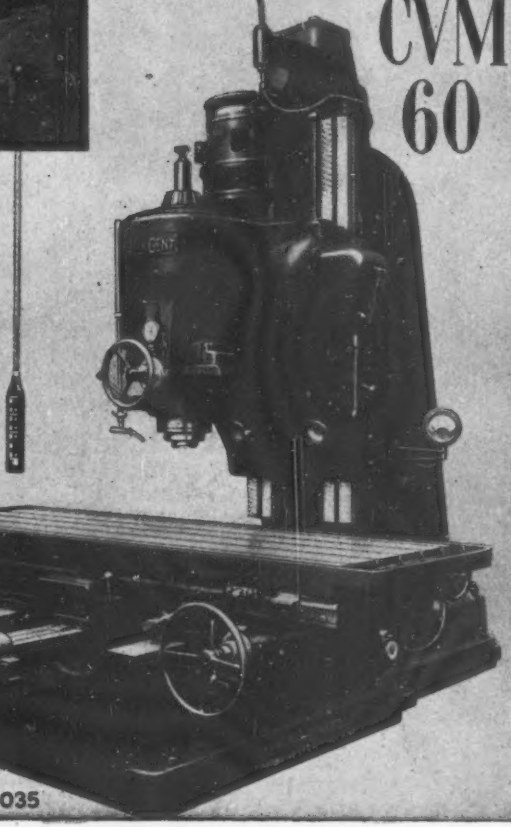
# VERTICAL MILLING





*Photographs by courtesy of The Express Lift Co. Ltd. Northampton*

## WITH THE CVM 60

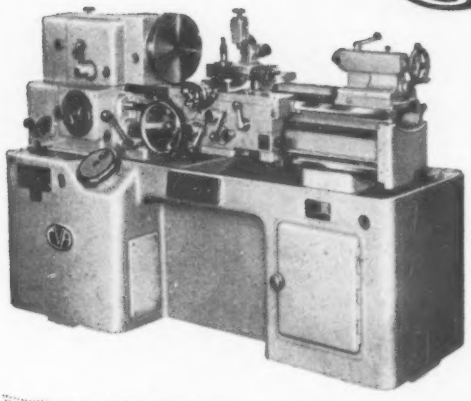


THE CVM.60 combines maximum production with extreme accuracy and easy operation. Powered by a 25 h.p. or 40 h.p. motor as required, spindle speeds range from 15 to 840 r.p.m. in eighteen steps. Rectangular table type has working surface of 9 ft x 2 ft 9 in, and traverses 7 ft 2 in x 3 ft 3 in, with a choice of four feed ranges. Other models available with circular table or combined circular and rectangular table. Maximum height under spindle nose is 3 ft 5 in.

KENDALL & GENT LTD

GORTON MANCHESTER *Phone* EAST 1035

K 227

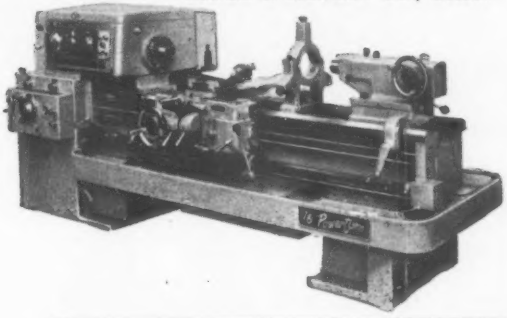


## IA (MARK III) PRECISION TOOLMAKER LATHE

**For high surface finish but at the same time, rapid stock removal. The Model 1A swings 12¼" over the bed and has 30" between centres. Speeds between 25 and 3,100 r.p.m. are available. Power is transmitted from a 4 h.p. main drive motor. Flame hardened bedways ensure continued accuracy over a long life.**

## TOOLMAKER CVA LATHES

**HEAVY DUTY AND STANDARD TOOLMAKER LATHES MANUFACTURED BY C.V.A. JIGS, MOULDS & TOOLS LTD. UNDER LICENCE FROM THE LODGE & SHIPLEY CO., OHIO.**



LODGE & SHIPLEY

*Powerturn* **TOOLMAKER LATHES**

**Computing head calculates correct cutting speeds and indicates correct lever settings.**

**24 Spindle speeds up to 2,000 r.p.m. Alternative motors transmitting up to 20 h.p. through all-spur gearing, with precision bearings. Flame-hardened, replaceable, steel cross-slideways and bedways.**

Model 13" swings 18" over bed.
Model 16" swings 20¼" over bed.
Model 20" swings 24¼" over bed.
All models available with 54", 78", or 126" between centres.

E.H. JONES (MACHINE TOOLS) LTD

GARANTOOLS HOUSE
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Telephone: HOVE 47253 Telegrams: Garantools, Portslade

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NRP 1248

*a NEW development in HACKSAW design*

*the*

# VAUNSAW

**FULLY AUTOMATIC HACKSAW**

**The Vaunsaw Automatic Hacksaw embodies in a British-built machine design features to bring it in line with the considerable advances made in other metal-cutting precision machine tools, achieving fast cutting rates, accuracy of length, squareness, and minimum material wastage.**

**Capacity—6in. round or square.**

**Strokes per min.—145 max.**

**Bar feed length (standard)—15ft.**

## VAUGHAN ASSOCIATES LIMITED

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NRP.1711

*Things take shape with*

**The Besco ALL STEEL Universal FOLDING MACHINE**
MARK II

**For intricate Bending and Folding**

**For hand operation. WELDED STEEL PLATE CONSTRUCTION with adjustable tension rods and braces—VIRTUALLY UNBREAKABLE. Adjustments to the folding beam and folding axis give sharp and round bends up to 1 in. true radius. Quick lever clamping: beam rises 2½ in. BEAMS ARE MOUNTED IN REPLACEABLE BEARINGS. Very narrow return bends can be made in thin material. Back gauges are available.**

**Made at our Chard Works and supplied in twelve sizes for 36 in. to 120 in. wide in 16, 14 and 12 S.W.G. mild steel with minimum 1 in. depth of flange. Popular sizes are 48 in., 72 in. and 96 in. wide x 14 S.W.G. Fuller details will be sent at your request.**

**DELIVERY GENERALLY EX-STOCK.**

***Specialist Box & Pan Folding Machines and Power Folding Machines are available.***

**Besco sheet metal working machinery made by**

**F. J. Edwards Ltd**

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FEDC

NRP 2140

# LANDIS *four-spindle semi-automatic threading machine*

**Speed of threading bolts, studs and rods.**

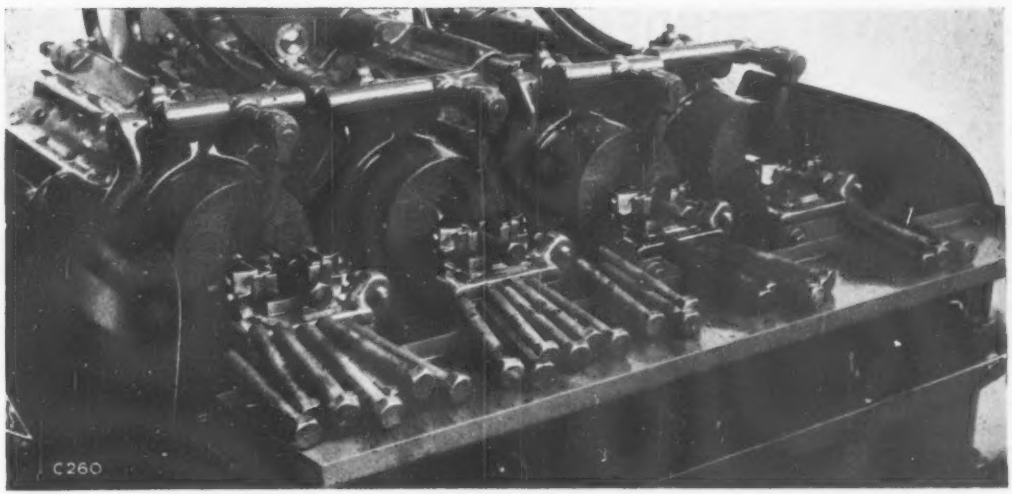
**Simplicity of setting and operation.**

**Ease of maintenance.**

For the high production threading of bolts, studs and rods. Two sizes for threads from ¼" to ⅞" × 3½" long and ½" to 1" × 3½" long.

The operator simply loads and unloads the grips as they automatically open. Production ranges from 500 to 2,000 per hour, depending on diameter and thread length. Standard or special gripping mechanism fitted.

The slow spindle speed feature of this machine increases the life of the chasers.




Cutting ¾" diameter by 1⅛" long Whit. threads on black bolts. Production, 1,650 bolts per hour. Rate of production largely depends on the speed of the operator loading and unloading the grips.

ALFRED HERBERT LTD., COVENTRY

AD.351

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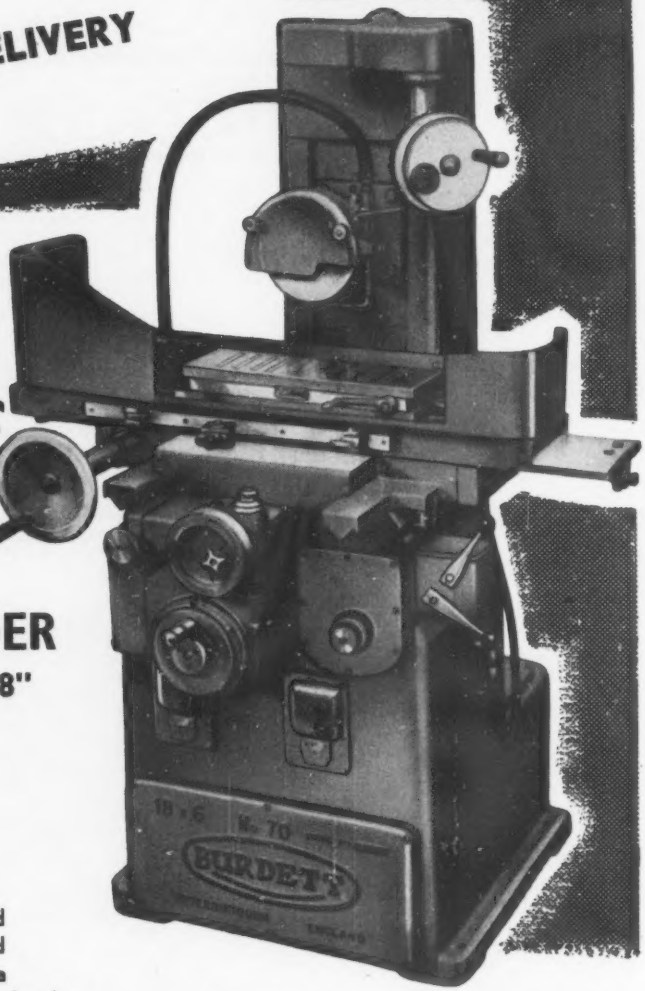


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*HIGH PRECISION*

## SURFACE GRINDER

**18" x 6" and 24" x 8"**

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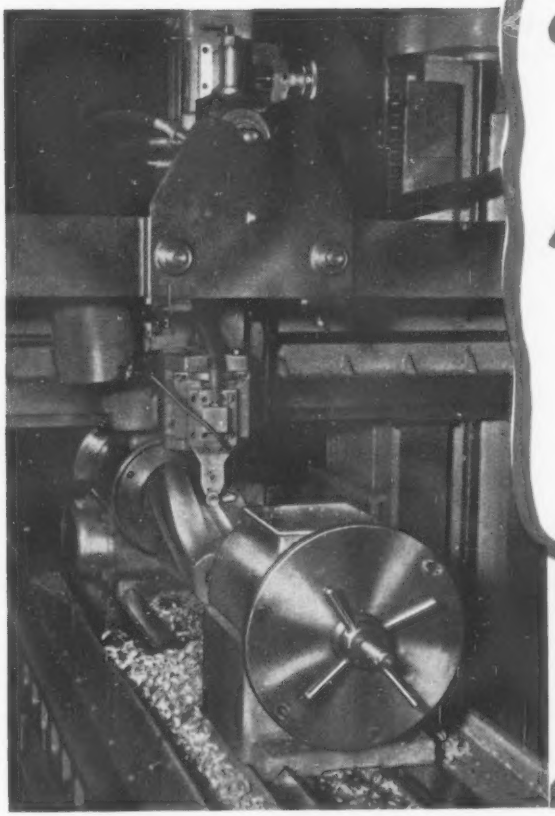
- *PRECISE*
- *RELIABLE*

A simple, hydraulically-operated machine, reasonable in price and capable of outstanding results on a wide range of work. Table traverse hand or hydraulic. Cross feed hydraulic, giving a movement in either direction of 0·010in. to 0·060in. per stroke. Nitralloy spindle in special lead bronze bearings, ensuring exceptionally accurate grinding to a good surface finish.

| MAIN DIMENSIONS | Model 70 | Model 75 |
|---|---|---|
| TABLE WORKING SURFACE ... | 18" x 6" | 24" x 8" |
| LONGITUDINAL TRAVEL ... | 19" | 25" |
| MAX. DISTANCE TABLE TO WHEEL ... ... ... ... | 9½" | 12" |
| VERTICAL MOVEMENT OF WHEEL ... ... ... ... | 10" | 12¼" |
| CROSS FEEDS ... ... ... | ·010" to ·060" per stroke | ditto. |
| TABLE SPEEDS (INFINITE) ... | 5-60 ft./min. | ditto. |

**G. W. S. BURDETT & CO. LTD. · EASTGATE · PETERBOROUGH · ENGLAND**



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N.8. The above illustration shows the conversion of a HYDETSCO planing machine for hydraulic copying spiral shaped components.

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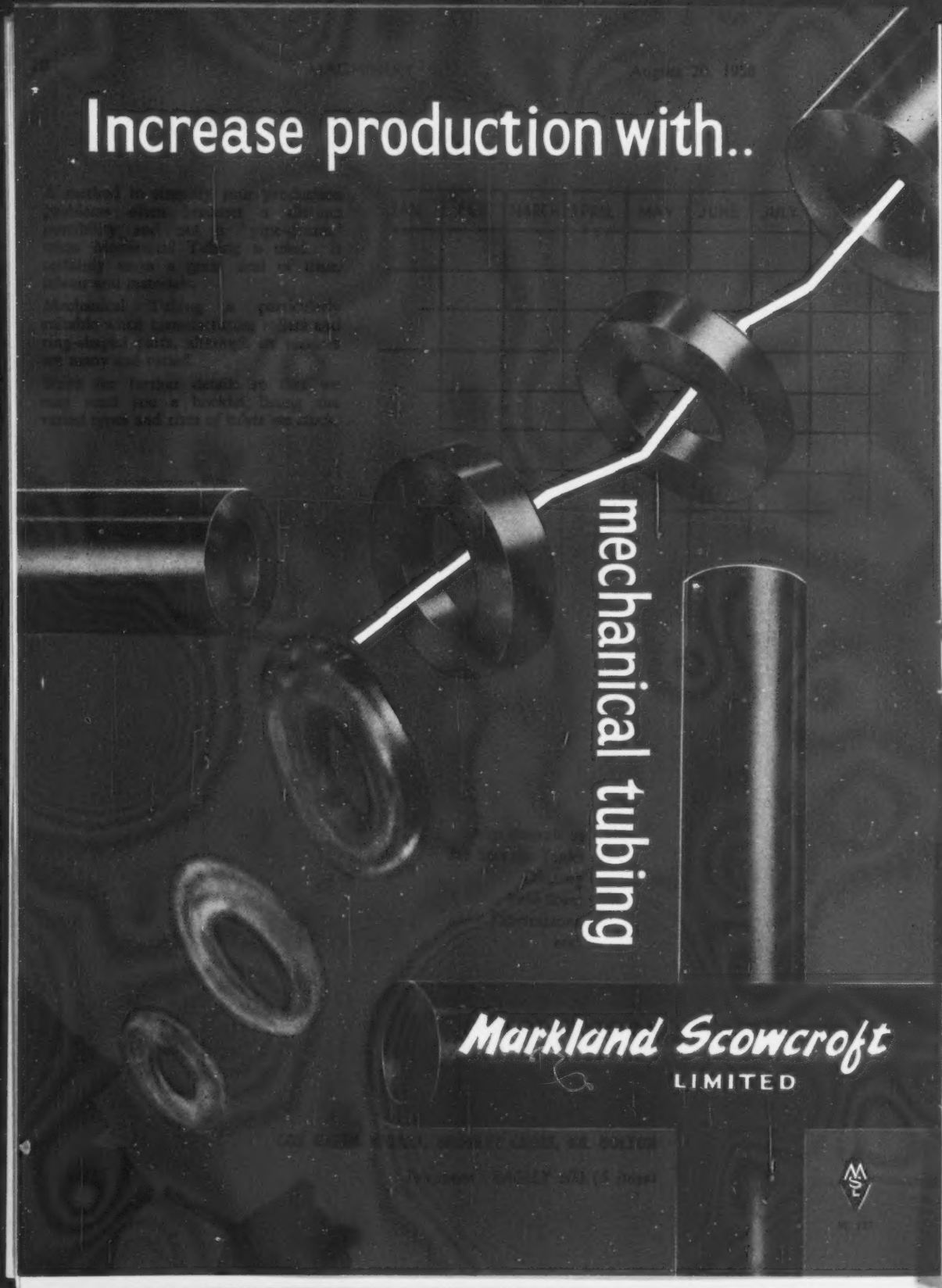
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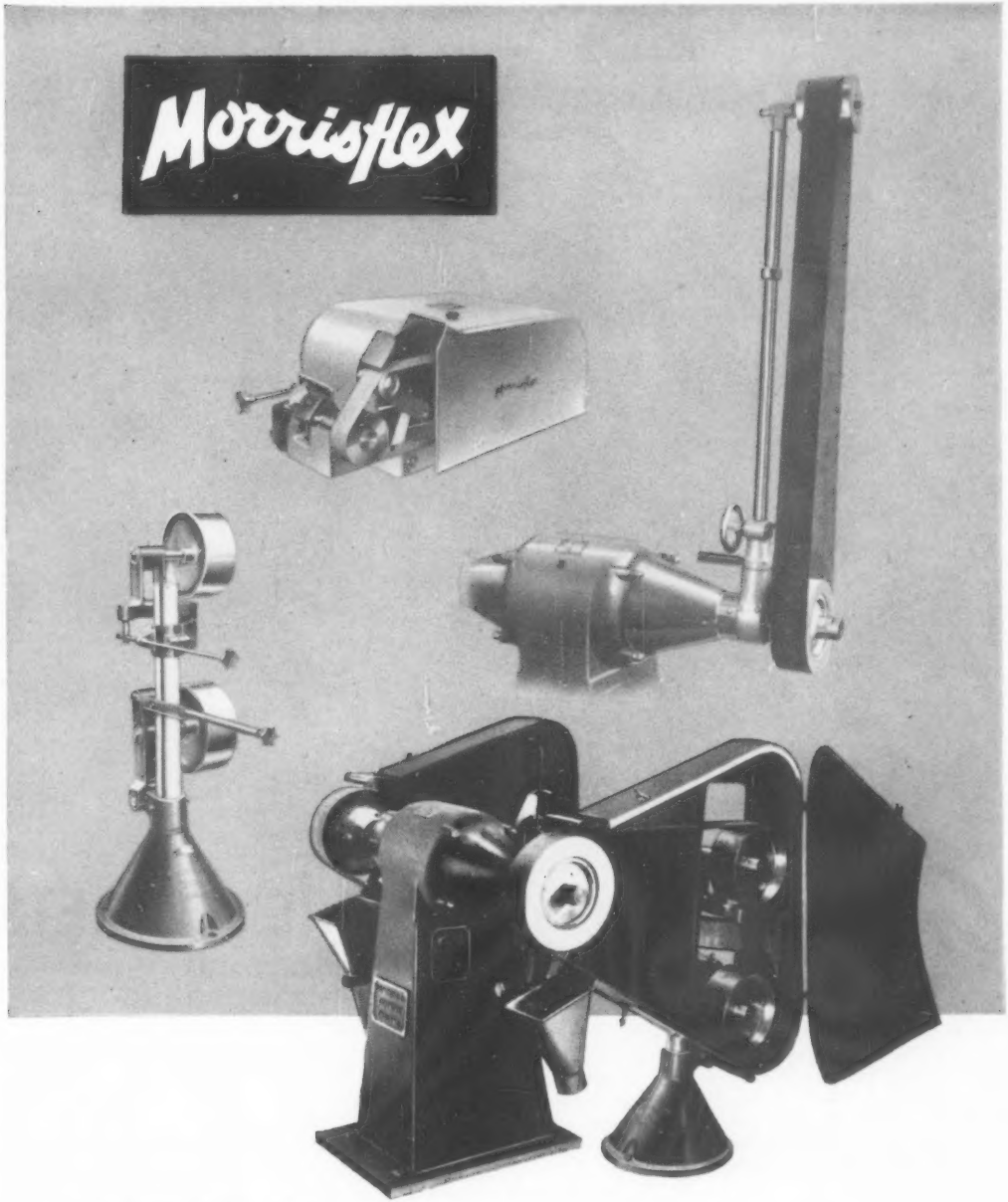


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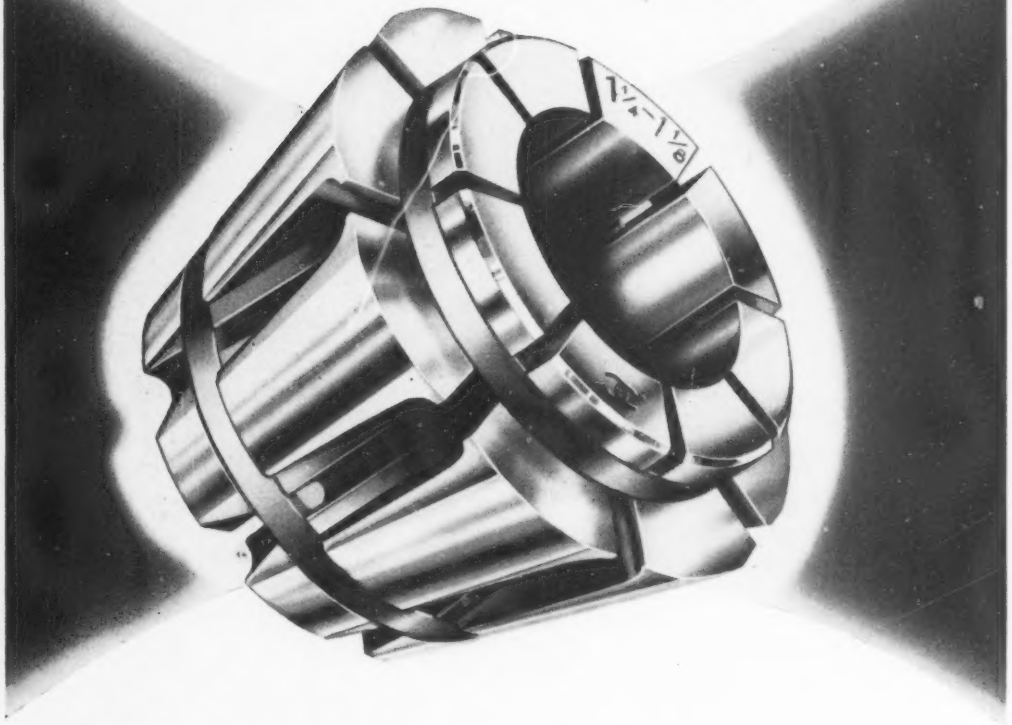

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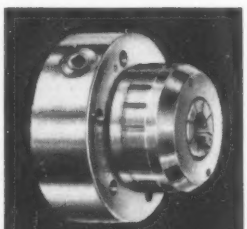

The Crawford Hydraulic Chuck

**CRAWFORD COLLETS LIMITED**

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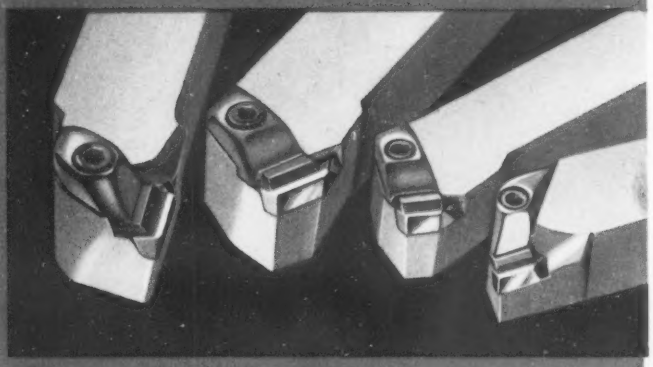
**2 types in 2 sizes = 4**



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**GAMMAX PRICES SLASHED**
Tremendous demand now makes this possible.
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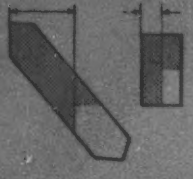
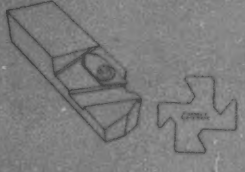
The mechanically fastened chip-breakers are provided in 2 sizes with the smaller holders (1" x 1" section) and 3 sizes with the larger holders (1¼" x 1¼" section) to allow for a wide range of feeds



The effective length of the GAMMAX insert is about the same as for three ordinary brazed-on tips. The great length combined with simplified regrinding gives good carbide economy.



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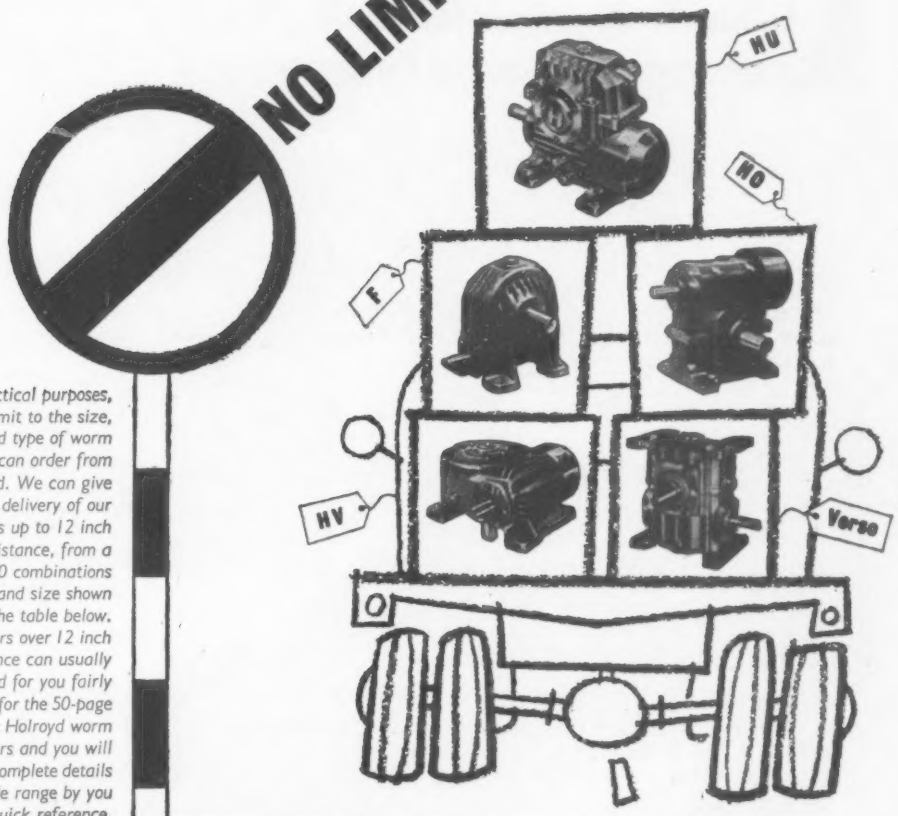


*For all practical purposes, there is no limit to the size, ratio and type of worm reducer you can order from Holroyd. We can give immediate delivery of our standard units up to 12 inch centre distance, from a choice of 340 combinations of type, ratio and size shown in the table below. Reduction gears over 12 inch centre distance can usually be assembled for you fairly quickly. Send for the 50-page book about Holroyd worm speed reducers and you will always have complete details of the whole range by you for quick reference.*

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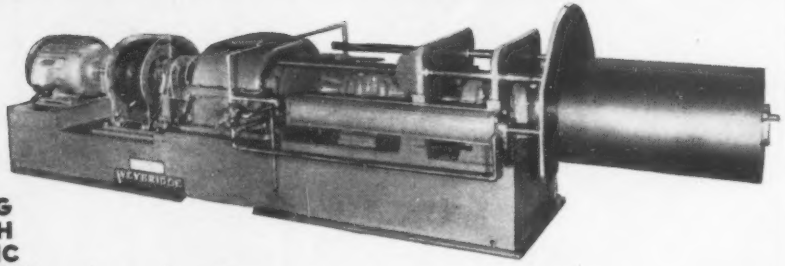
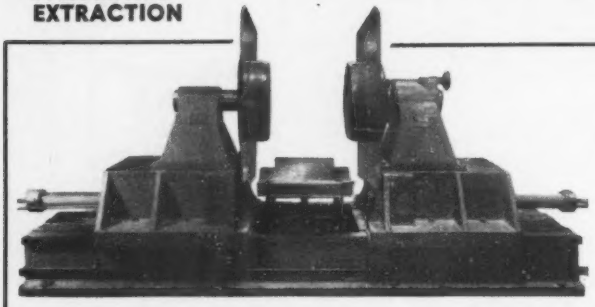


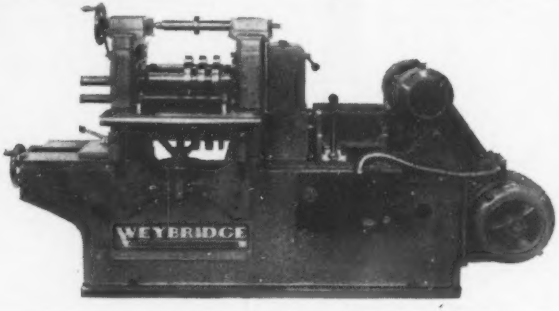

**RECOILING UNIT WITH PNEUMATIC EXTRACTION**



**CONE TYPE DECOILER WITH HYDRAULIC ADJUSTMENT**

**MEDIUM DUTY GANG SLITTER WITH ADJUSTABLE CUTTER SHAFT**

If you are interested in Gang Slitting of any description our technical representative will gladly visit you on request to discuss your requirements.

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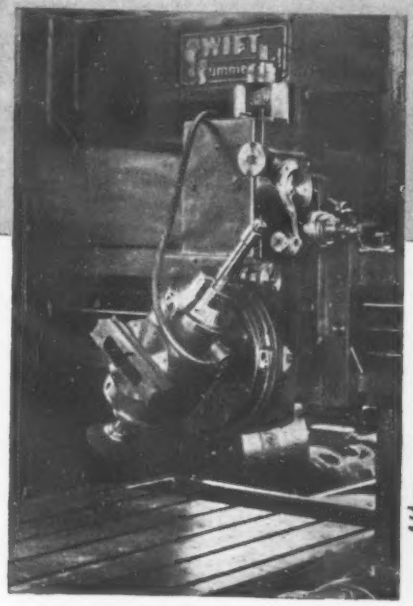
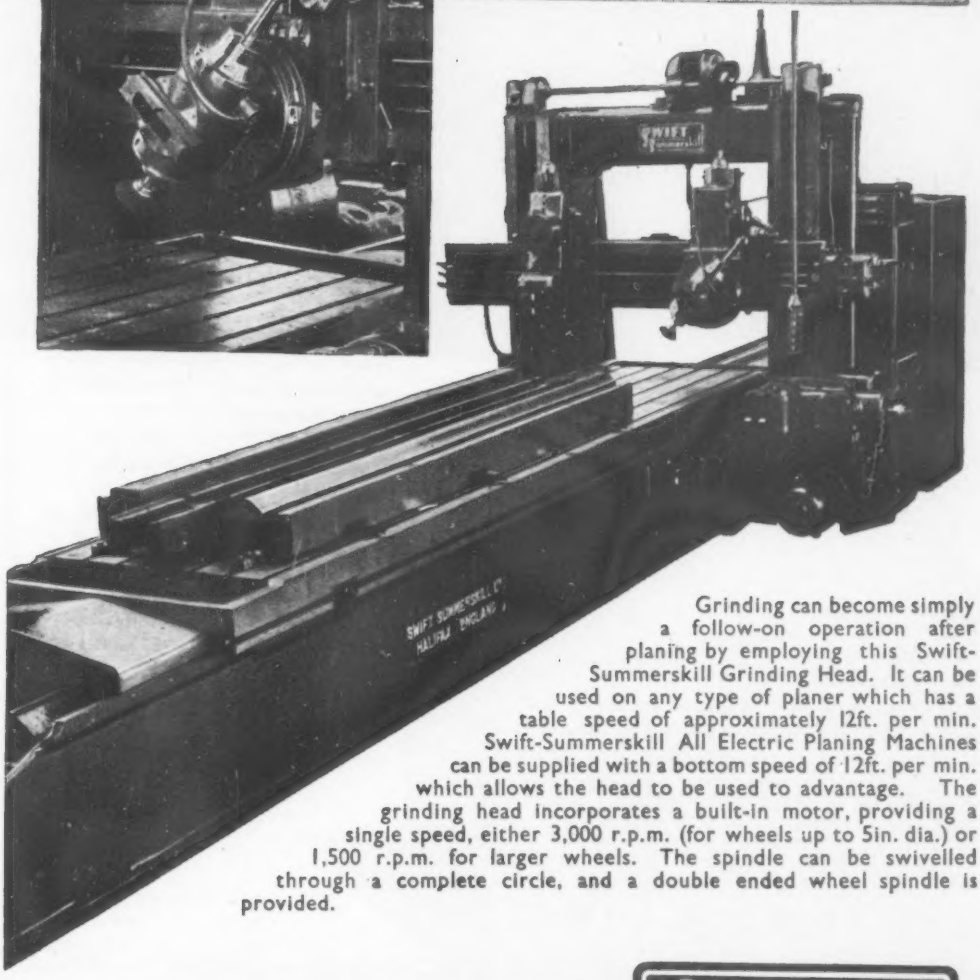
# GRINDING AFTER PLANING WITHOUT RESETTING THE WORK!




Grinding can become simply a follow-on operation after planing by employing this Swift-Summerskill Grinding Head. It can be used on any type of planer which has a table speed of approximately 12ft. per min. Swift-Summerskill All Electric Planing Machines can be supplied with a bottom speed of 12ft. per min. which allows the head to be used to advantage. The grinding head incorporates a built-in motor, providing a single speed, either 3,000 r.p.m. (for wheels up to 5in. dia.) or 1,500 r.p.m. for larger wheels. The spindle can be swivelled through a complete circle, and a double ended wheel spindle is provided.

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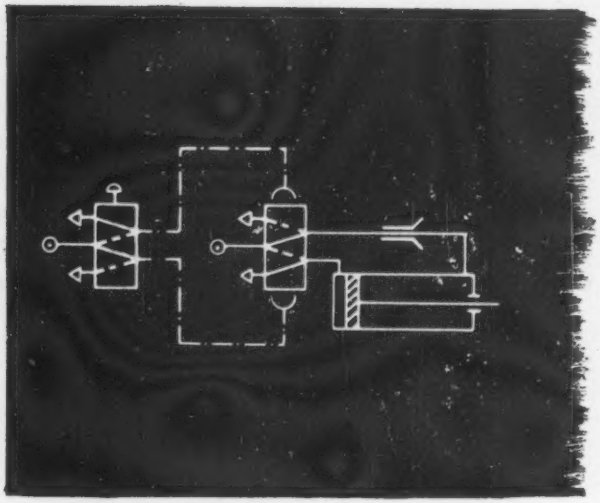

The double-pressure operated valve is so arranged that when the valves are in the position shown, with the internal connections of the valves as indicated with solid lines, the cylinder is in the retracted position. If the five-port pilot valve is operated, the internal connections are reversed, and mains air is applied to the top pilot port of the operating valve, in turn moving the valve piston and supplying air to the rear end of the cylinder, and exhausting the front end.

The air exhausting from the front end is restricted by a flow regulator and the piston rod will move outward at reduced speed. The unidirectional type of flow regulator shown is arranged to restrict air flow in one direction only, and when the pilot valve and operating valve revert to the positions shown by solid lines, mains air will pass to the front end unimpeded.

If required, a similar flow regulator could be fitted in the line to the other cylinder port to provide independent speed control in the other direction.

Note.—Flow regulators should be fitted between the cylinder and valve in such a manner as to restrict exhaust.

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Infinitely variable speeds. Power rise and fall to head with foolproof stops for automatic up and down feeds. Portable foot control switch for inching of spindle. Totally enclosed Lead Screws.

**TABLE 35½" by 12½"**

| | |
|---|---|
| Table Travel Longit. | 19¾" |
| Table Travel Cross | 12½" |
| Spindle Nose to Table | 23⅜" |
| Sliding Head Travel | 19 11/16" |
| Drilling Capacity in Steel | 1 5/16" |
| Boring Capacity in Steel | 5/8" |
| Spindle speed - R.P.M. | 70-1300 |
| Spindle Feeds | 4 |
| Table Position in Accuracy | 0·0002" |

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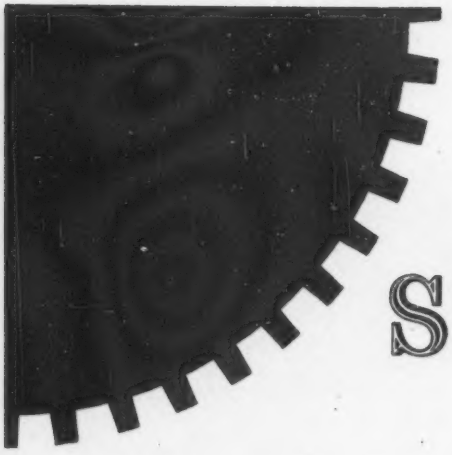

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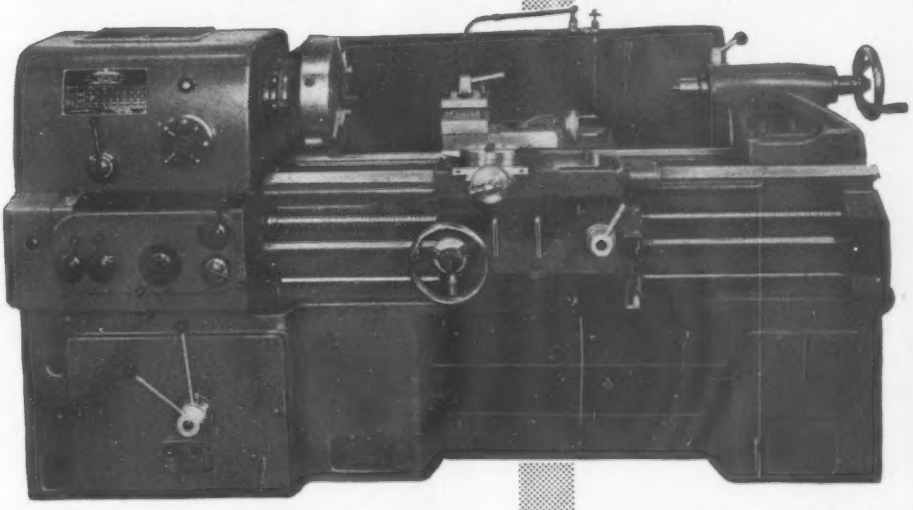

## 3 1/16" SPINDLE BORE

| | | |
|---|---|---|
| 18 | Spindle Speeds | 20-1,000 r.p.m. |
| 80 | Sliding Feeds | 0.0023"-0.232" |
| 80 | Surfacing Feeds | 0.0009"-0.096" |
| 56 | English Threads | ½-30 T.P.I. |
| 24 | Metric Threads | 0.5-30mm |

***ALL FEEDS AND THREADS OBTAINED BY SINGLE LEVER SETTINGS***

- **Gap bed 30", 48", 80" and 100" — alternatively chip flow bed 48" and 80".**
- **Patented totally enclosed feed box.**
- **Hardened and ground gears in gearbox and headstock —all meshing faces tooth rounded for easy engagement.**
- **Patented snap action controls on apron—feeds can be varied whilst cutting.**
- **11" (22" swing) Crusader model also available.**

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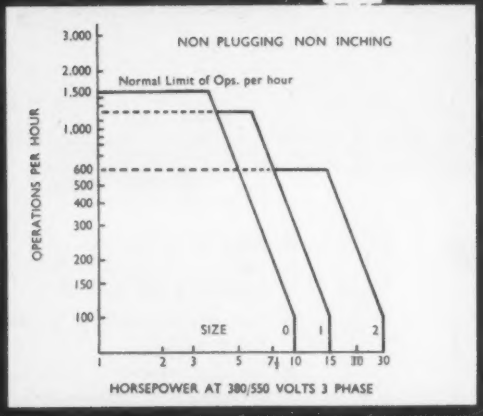
and I must have long-term reliability, demanded the works manager

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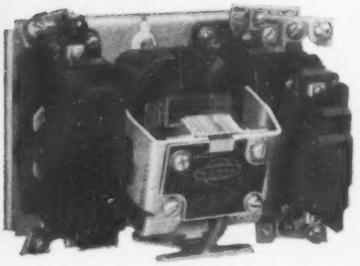

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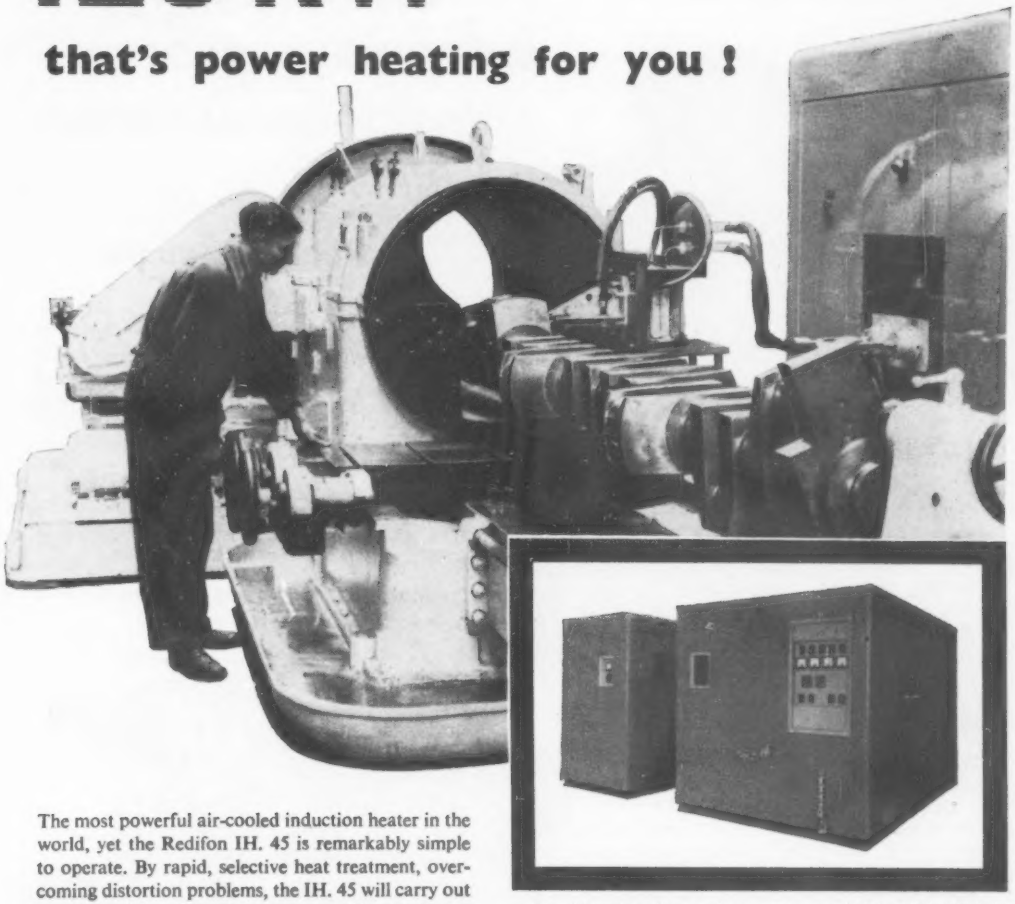

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*The illustration shows a large marine crankshaft which Mitchell-Shackleton & Co. Ltd. are heat-treating for one of their customers.*

**Redifon IH 45**

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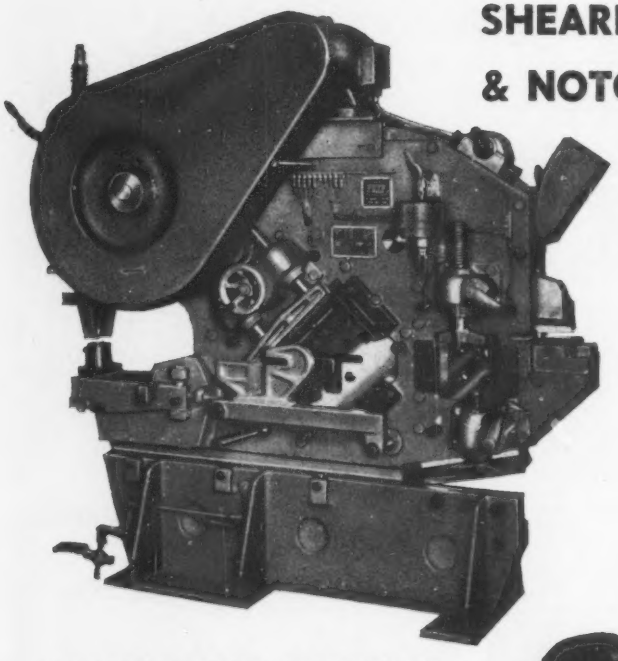
## UNIVERSAL PUNCHING SHEARING · CROPPING & NOTCHING MACHINES



### MODEL 'STANDARD'

This model is built in five sizes with shearing capacities from ½ to 1". The five operations are contained in one compact and sturdy power driven unit with separate working positions for punching, shearing angle and section cropping, bar cropping and notching. Alternative models, without punching motion (Model 64), and single purpose punching machine (Model 341).

## ALLIGATOR SHEARS

These shears, part of a complete range of shears by "Ficep," are made in four sizes (CCL 400, CCL 600, CCL 750, CCL 1,000) with a comprehensive mild steel capacity up to 3⅛" round bars, 3 7/16" square bars, 12" beams, 10" channels and large range of plates and flats. Full specifications of each machine, with details of other machines made by "Ficep," are contained in a leaflet "Shearing Machines by FICEP" which will be sent on request.

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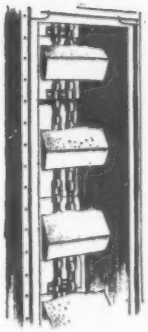

With their all-steel construction, accuracy of manufacture, and high ratio of strength to weight, they are the hallmark of a first class conveyor installation. These features mean least power consumption for the load moved, and the avoidance of excessive weight in conveyor structures.

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## Balancing Tractor Flywheels —

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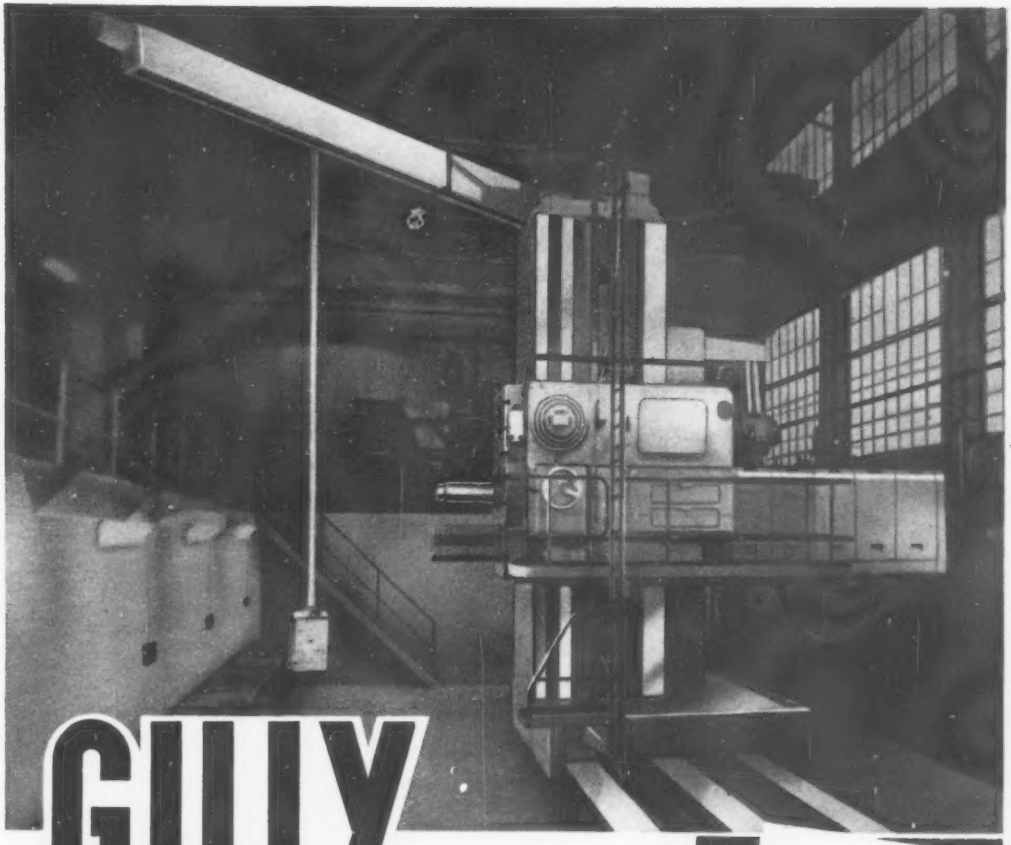

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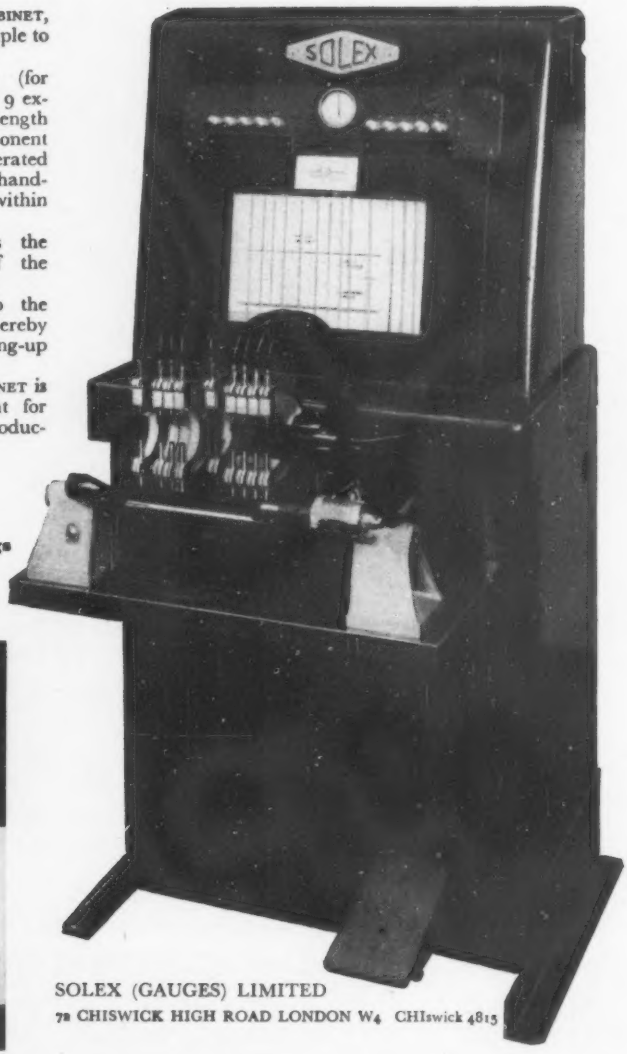


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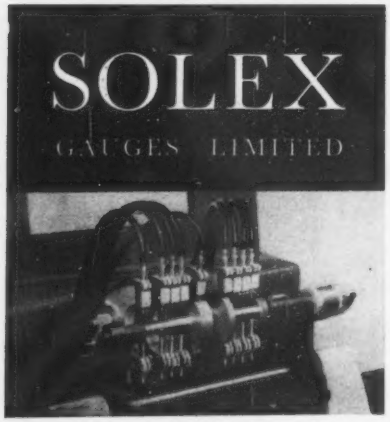


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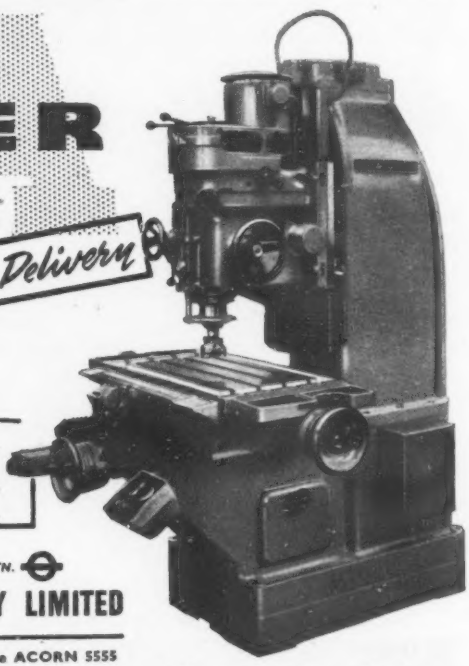

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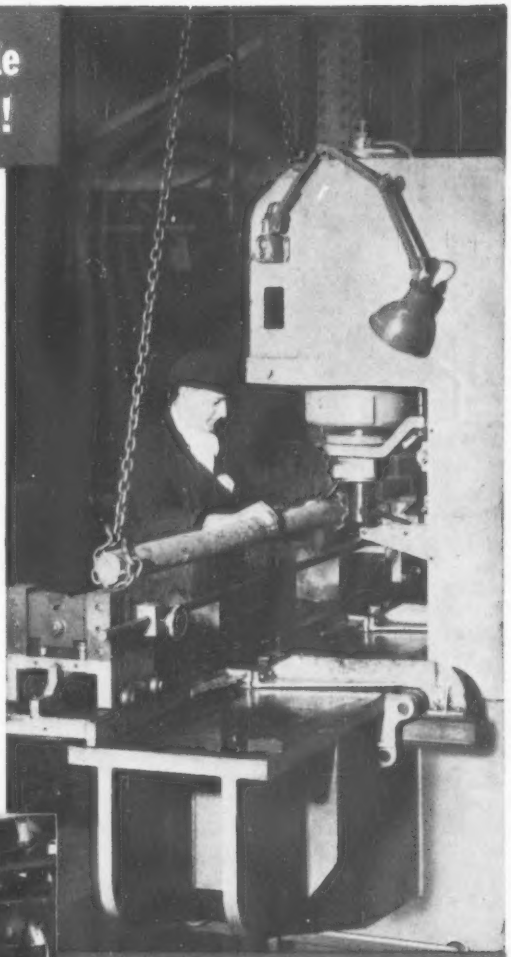

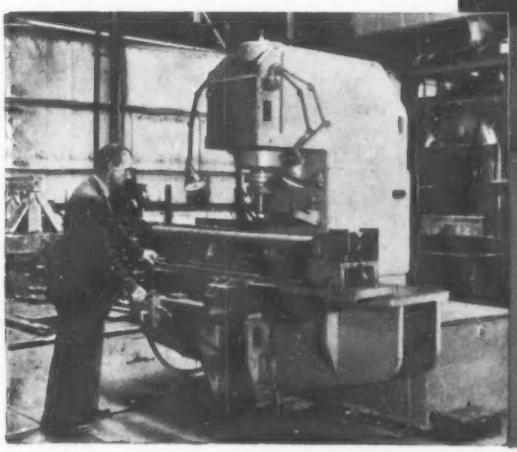

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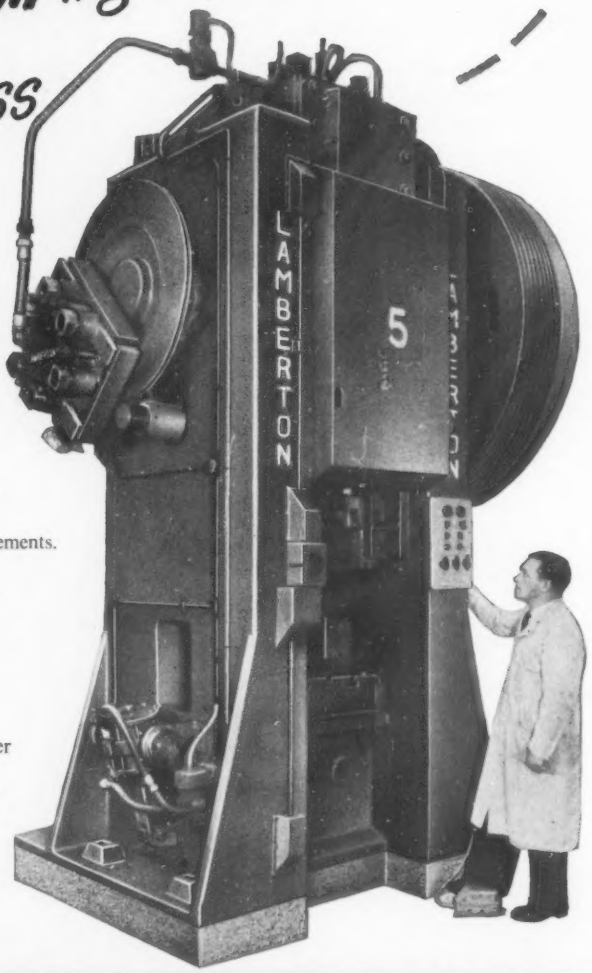


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Our own design giving excellent performance under severest conditions.

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air operated, adjustable to suit all requirements.

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can be limited to every second or third stroke as required.

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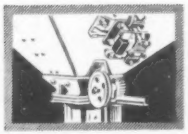
**For measured handling of powder or gravel**



**Syntron Electric Vibrators** keeps bins and hoppers clear with adjustable electro-magnetic vibration.

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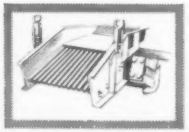
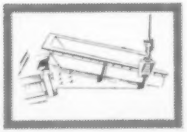


**Syntron Grizzly Discharge Feeders** give high capacity feeding, and screen and separate fines from abrasives.



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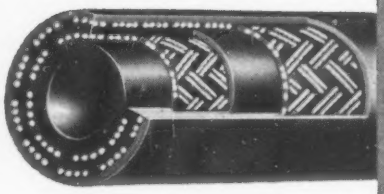
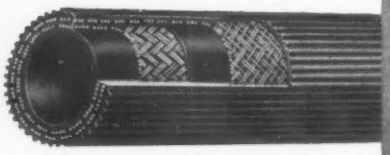


STYLE A *for service where oil mist may be present in the line, and where operating pressures up to 325 lbs. per sq. in. are used.*



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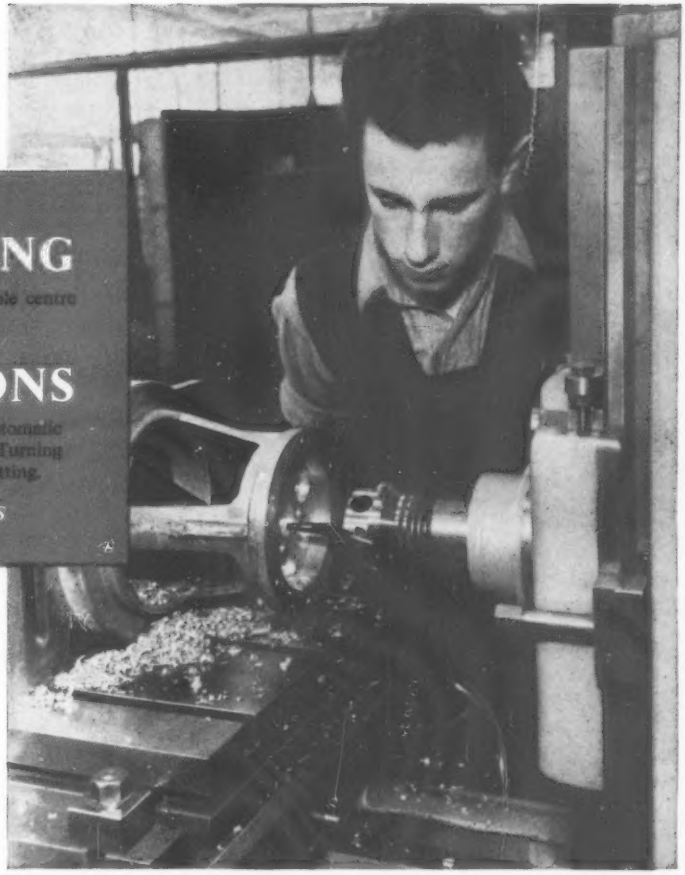

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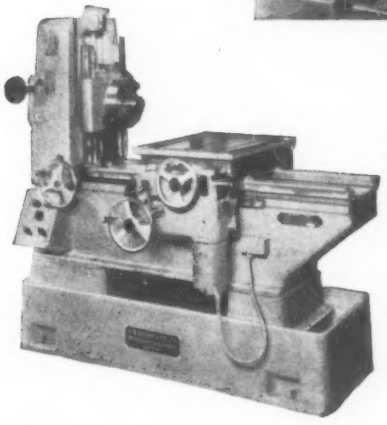

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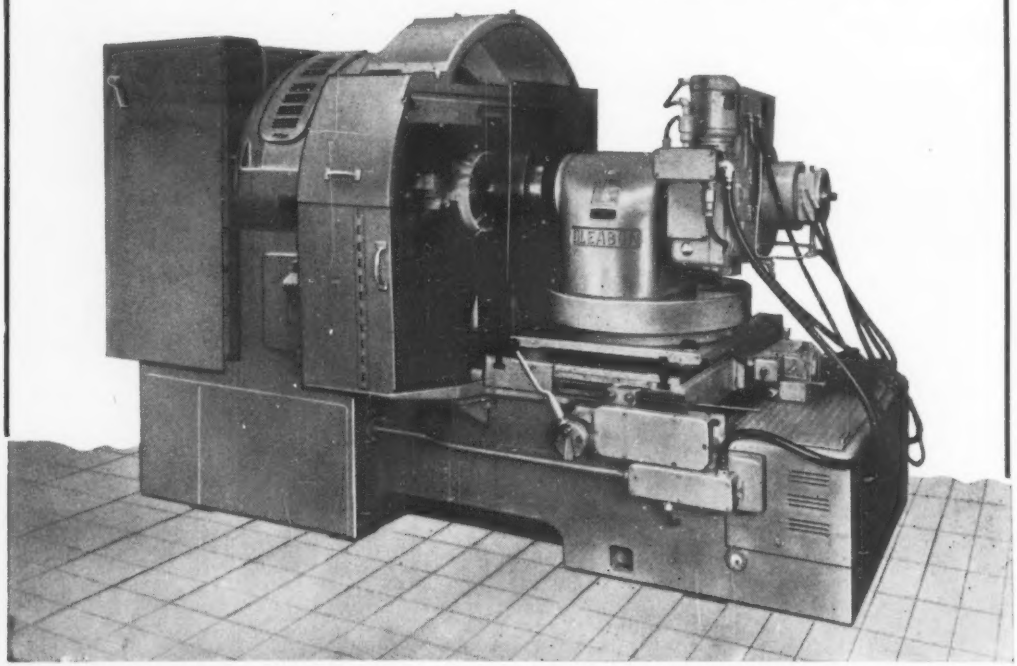

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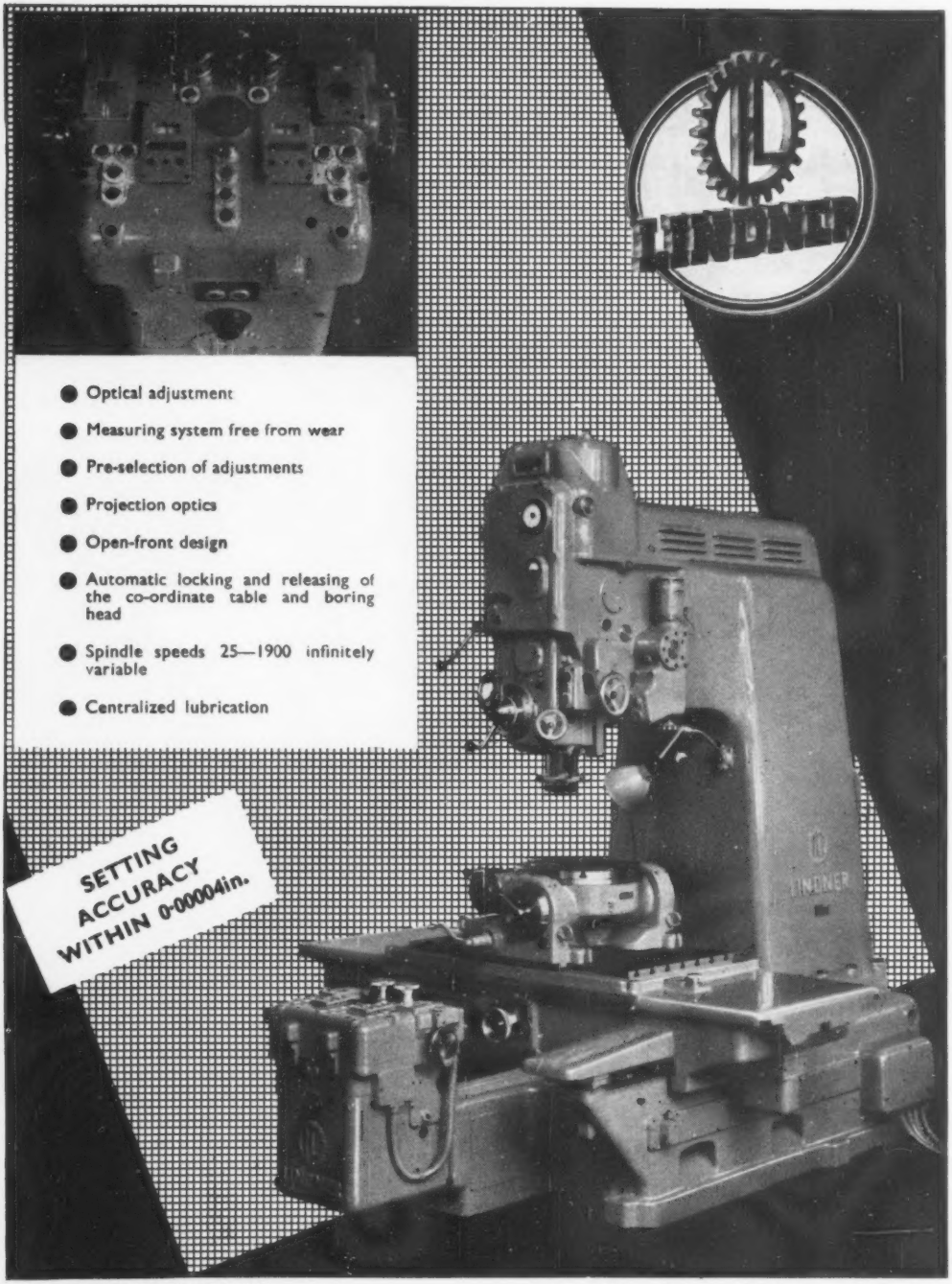
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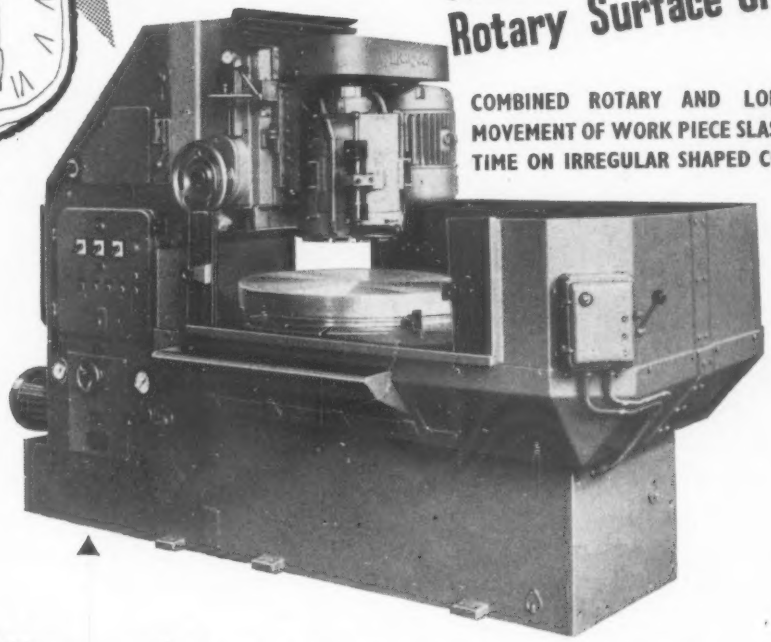

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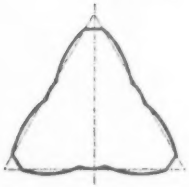

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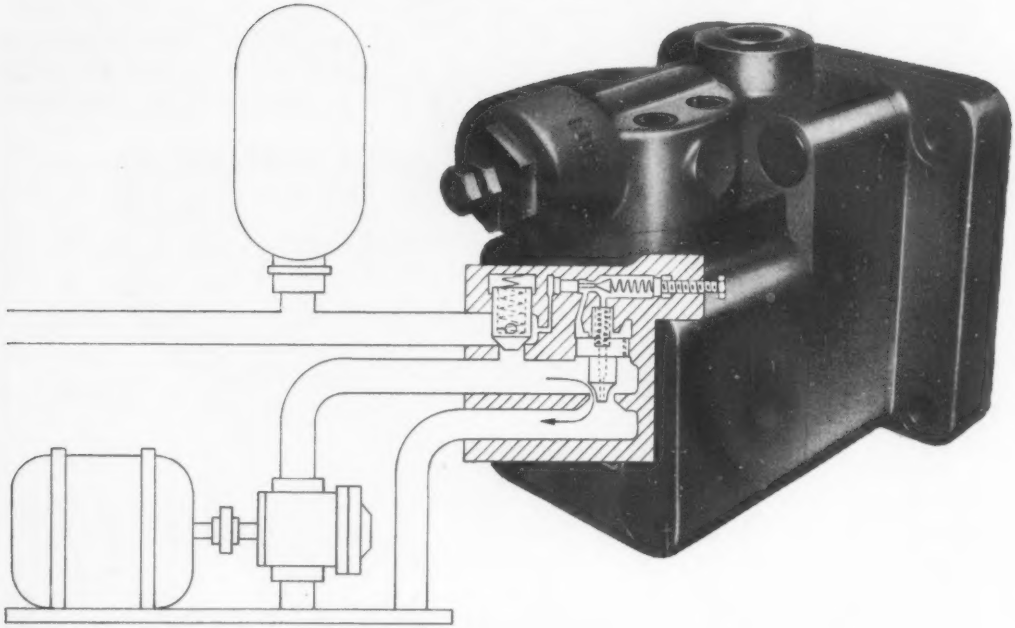

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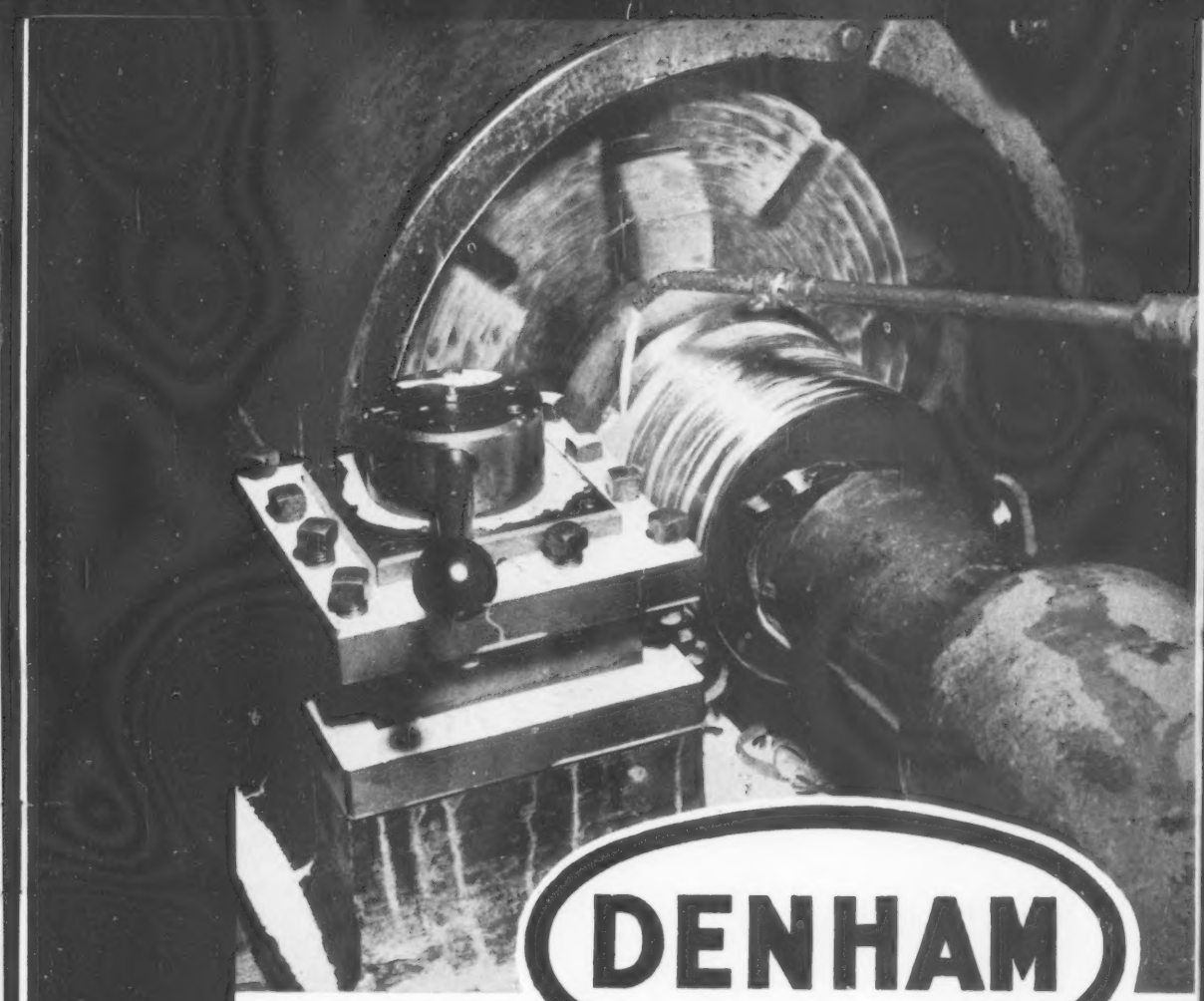

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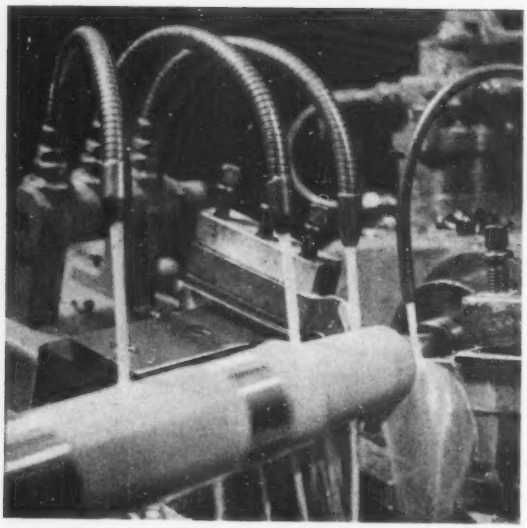

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Many components now used in industry and produced from these materials by a variety of other processes, lend themselves to production by impact extrusion with consequent saving in cost and material. This cold forming process induces added strength in parts by utilising the grain flow, and produces a smooth and flawless finish.

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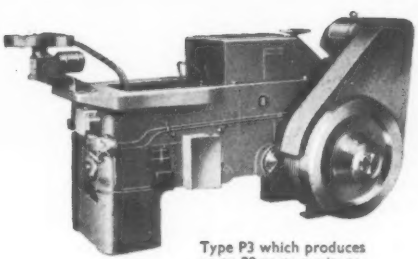
Herlan presses are available with production rating from 35 to 95 parts a minute. Extrusions up to 4¾" diameter (aluminium) at a wall thickness of 0·011" and maximum length of 12¾" may be obtained from these versatile machines.

### *Automatic operation*

The presses are entirely automatic, and after loading, feed, form, strip-off and eject in rapid sequence. The horizontal working stroke is smooth and the shockless operation promotes long tool life.



Type P3 which produces up to 90 parts a minute.

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## EXTRUSION PRESSES

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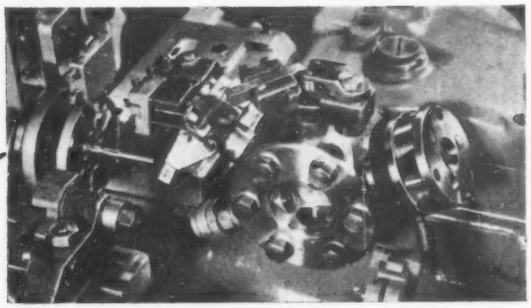
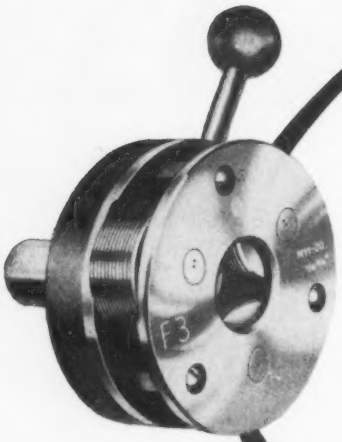


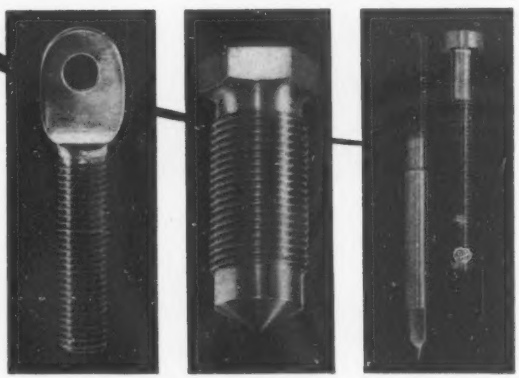


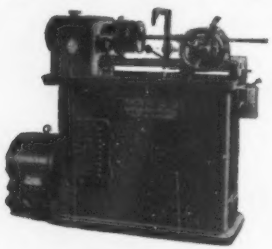
BETTER THREADS MORE QUICKLY FOR LESS COST WITH

# MSE—"FETTE"
# THREAD ROLLING HEADS

British Patents Nos. 705754, 744039 & 743977

**Thread rolling, as opposed to cutting, has enormous advantages* — and can be carried out on your existing lathes, capstans, automatics and drilling machines, with MSE-"Fette" Self Opening Thread Rolling Heads.**





**MSE-"FETTE" THREAD ROLLING MACHINE**

*This machine has been designed for use with MSE-"Fette" Heads where volume of threads production calls for a special purpose machine. It is suitable for a range of Heads for threads up to 1¼in. diameter.*

* Denser, stronger threads with a hardened surface. Faster, more economic production. Perfect threads on many "unmachinable" materials. Sustained accuracy on long runs. Saving in material costs.

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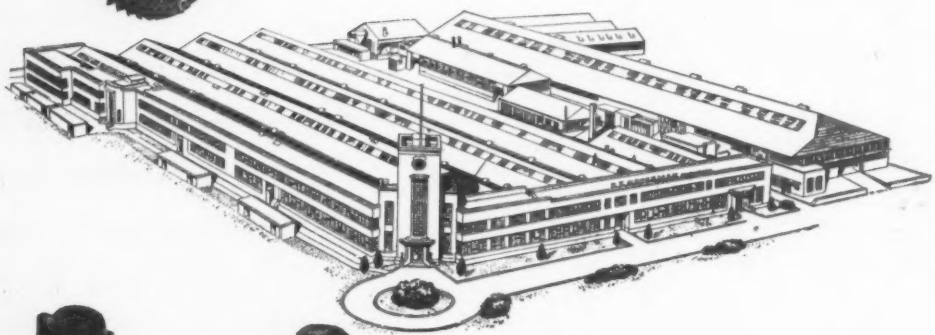

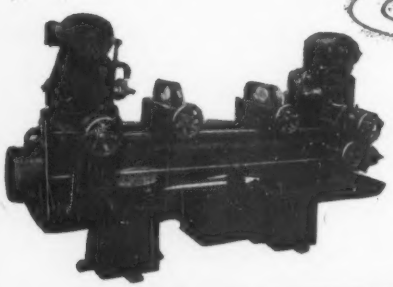

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(Splash guards removed for purpose of illustration.)

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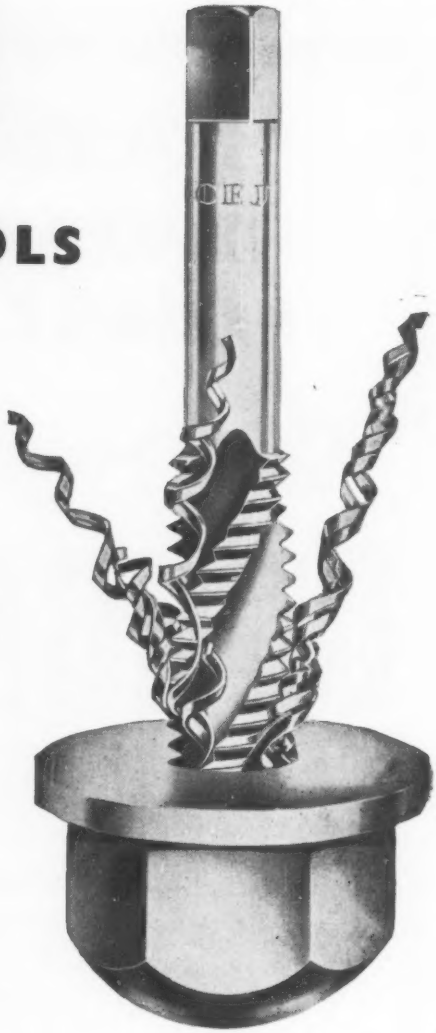


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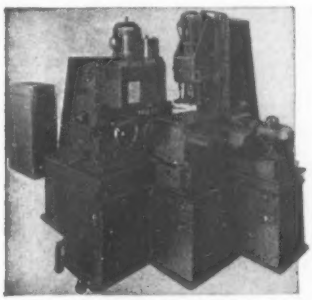
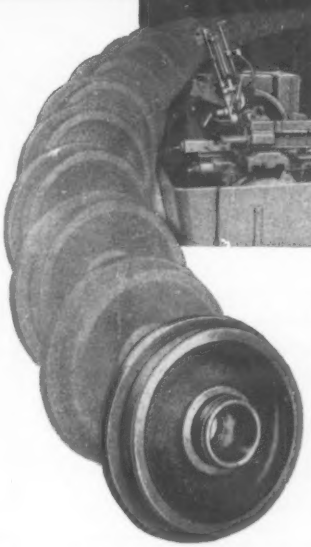
**This is one of the possibilities of the automatic linking of B.S.A. machines. When the requirement is for medium or high-production, on standard or special purpose machines, consult B.S.A. Tools Limited**



B.S.A. Hüller combined mill and drilling machine for transmission boxes.



THIS 4" dia. COMPONENT MACHINED COMPLETE on a B.S.A. 5M single-spindle automatic chucking machine (for 1st opn. work) linked with a B.S.A. ACME-GRIDLEY 6" six-spindle chucking machine. After 1st opn. machining the component is conveyed via the overhead chute to the multi-spindle machine. The component is transferred to the chucks electro-pneumatically within the automatic cycle of the machines.

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From the B.S.A. range of single- and multi-spindle automatic bar and chucking machines, thread and form generators, multi-tool and copy turning lathes, centreless grinders, broaching machines, special purpose machines and small tools.

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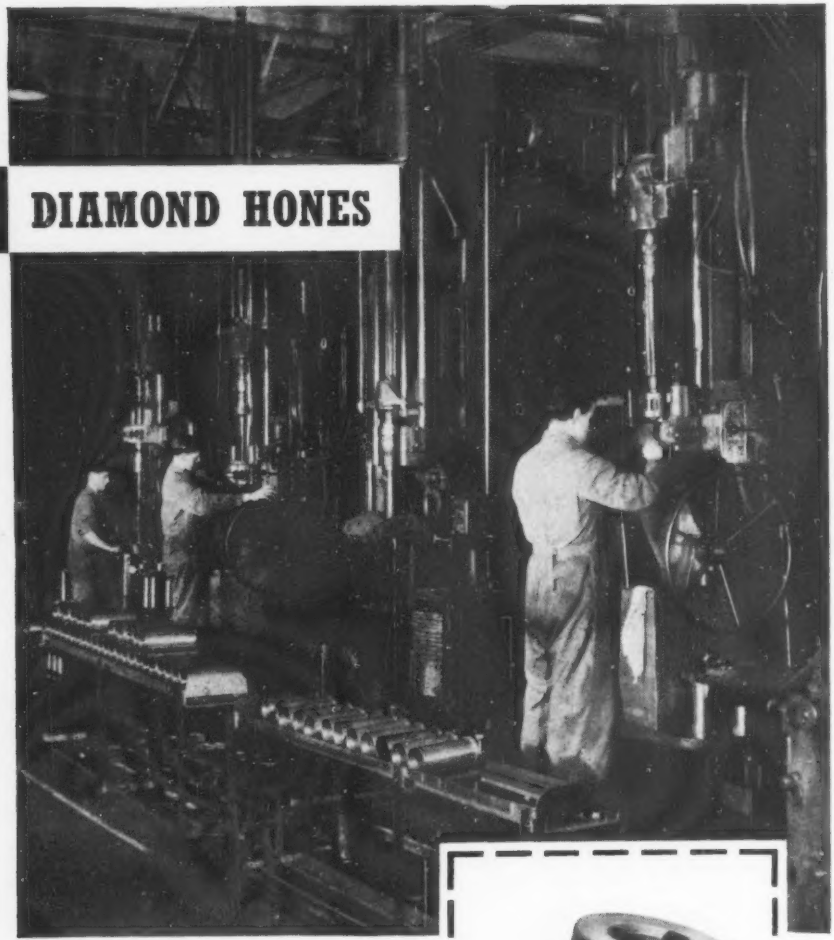
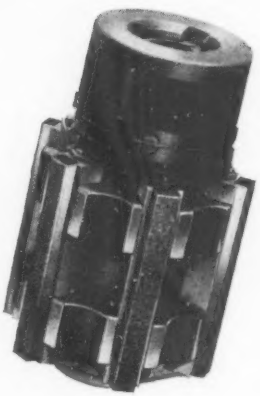


*(Photograph by kind permission of Leyland Motors Ltd.)*

Neven hones are used by the leading engineering firms. The illustration shows our hones in use at Leyland Motors Limited.



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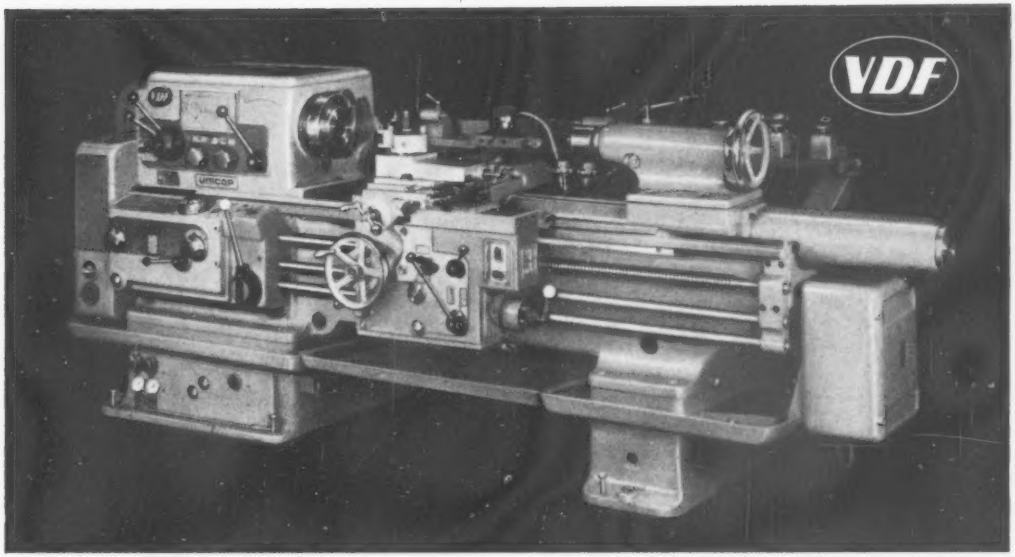


# Ultra-Sensitive Multi-Purpose VDF Unicop I Copying Lathe

- So sensitive it can produce a sphere.
- Ideal for workshops where a single-purpose copying lathe would be uneconomical.
- For normal *and* copy turning.
- Suitable for longitudinal, external and internal copying and face copying.
- Electronic-hydraulic.
- Copying traverse up to 29½" and cross copying to 5". Increased if required.
- Can be delivered with high-speed headstock (top speed up to 5,600 r.p.m.).
- Also available Unicop III for production copying and Unicop V giving greater capacity for shaft work.

**BRIEF SPECIFICATION**
(3 models available)

| | | | |
|---|---|---|---|
| swing over bed | 20¼" | 20¼" | 26½" |
| centre distance (normal turning) up to | 118" | 118" | 118" |
| max. copying length | 39½" | 39½" | 39½" |
| height of centres | 10" | 10" | 13" |
| main spindle bore | 2½" | 2½" | 3" |
| no. of speeds | 30 | 18 | 18 |
| speeds r.p.m. | 9–1800 | 22.4–1120 | 11.2–560 |
| | | 28 –1400 | 14 –710 |
| | | 35.5–1800 | 18 –900 |
| motor h.p. up to max. | 26 | 19 | 32 |

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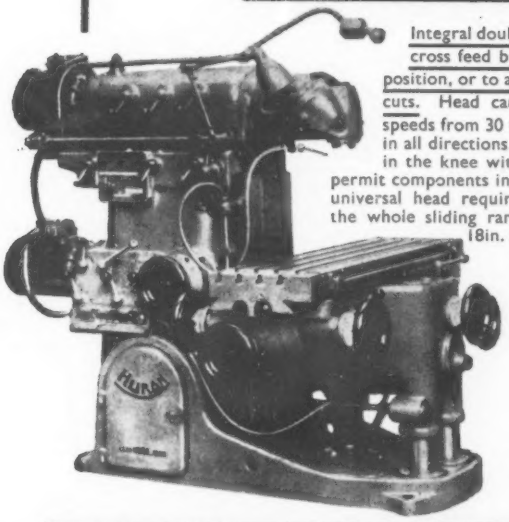
ANGULAR COMPOUND HORIZONTAL VERTICAL

# HURON SUPER UNIVERSAL MILLERS

SLIDING RAM GIVES 27½in. AUTO CROSS FEED



Integral double swivelling universal head provided with 27½in. automatic cross feed by the sliding ram, can be set to the horizontal or vertical position, or to any angle instantaneously—permits the heaviest production cuts. Head can be retracted completely from table line. 27 spindle speeds from 30 to 2,066 r.p.m. 27 feeds from $\frac{1}{12}$in. to 30in. Rapid traverses in all directions. All operating controls duplicated. Table slides directly in the knee without cross movement or swivel. Double guides of knee permit components in excess of 1½ tons to be machined. The double swivelling universal head requires an opening of only 14in. to enter work pieces and the whole sliding ram with its 27½in. automatic cross movement needs only 18in. clearance.

| Type | Table | Automatic Feeds Long | Cross | Vert. |
|---|---|---|---|---|
| KU4 | 56$\frac{5}{16}$in. × 15¾in. | 43½in. | 27½in. | 19¾in. |
| KU5 | 64$\frac{5}{16}$in. × 15¾in. | 51½in. | 27½in. | 19¾in. |
| KU6 | 78⅝in. × 16¼in. | 59in. | 27½in. | 19¾in. |
| L7 | 157in. × 39in. | 118in. | 27½in. | 39⅜in. |

**Type 'L' Open-side Traversing Head Universal Miller** will mill, bore, slot and drill the largest work-pieces at one setting.
The unique design permits greatest variety of operation on large work-pieces; the component remains stationary on the large work-table. Upright slides full length of base table, and the sliding ram moves vertically and horizontally.

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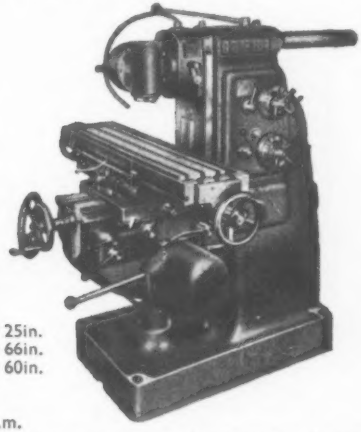
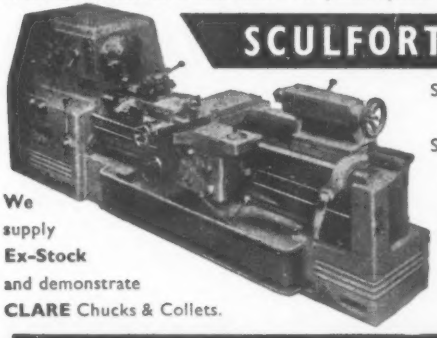
Table surface 43$\frac{5}{16}$in. by 9⅞in. or 47½in. by 10⅞in. Auto long. feed, 26¾in. or 30¾in. Auto vert. feed, 15¾in. or 18⅞in. Auto cross feed 9½. Rapid traverse in all directions. No. 40 International taper for main spindle, universal head, and rotary table. Direct reading dial change for speeds and feeds. All parts subject to wear hardened and ground and completely interchangeable. Built to closest tolerances. Spindle speeds 21 to 1,600 r.p.m. Twin overarms. Separate motor for rapid traverses.

Also table 63in. by 15in., with auto feeds: 40in. long., 21in. vert., 14in. cross; 25in. auto-univ. head feed. 36 spindle speeds 6 to 1,500 r.p.m.



## SCULFORT LATHES



Swing over bed 20, 22 or 25in.
and 28, 32 or 66in.
and 40, 47 or 60in.
Speed ranges: 6-2,000;
12-1,600;
or 3½-325 r.p.m.

18-45 h.p. motor drives for max. output. Totally enlcosed gear box provides 90 different pitches. Flame hardened bed. Large spindle bore. All head stock gears hardened and ground. Built-in coarse screw cutting device.

*Other products: Copying lathes, Locomotive and Carriage Wheel Turning Lathes, Centreless Bar Turning Machines, Facing Lathes and Special Purpose Centre Lathes.*

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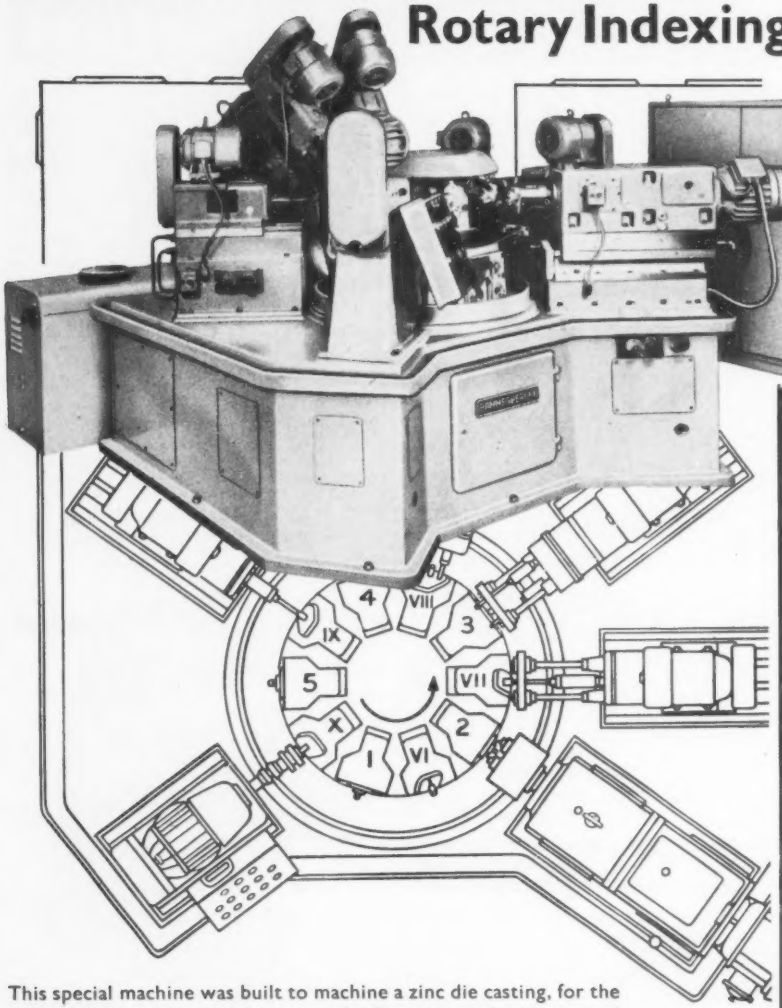
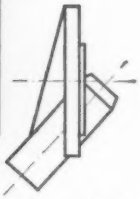
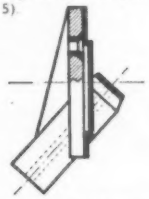
# BAMMESBERGER

## Rotary Indexing Machine

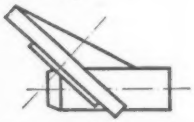


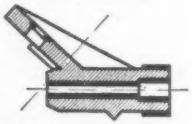
Casting loaded for machining during 1st rotation (stations 1 - 5).



Parts shown after 1st rotation (faced, drilled and spotfaced end milled).



Part premachined at stations 1 - 5 loaded for stations VI - X (2nd rotation).



Finished part after 2nd rotation (step drilled, deburred, reamed, tapped).

Output: approx. 220 pieces per hr. at 85% efficiency.

This special machine was built to machine a zinc die casting, for the windshield wiper bearing shown at right. The operator's job is limited to loading, reclamping and unloading of these parts. The machine is built up of three single-spindle drilling units, two slide units with built-on 2-spindle drilling heads, one facing unit with hydraulic shuttle table, one tapping unit and one hydraulic rotary indexing table.

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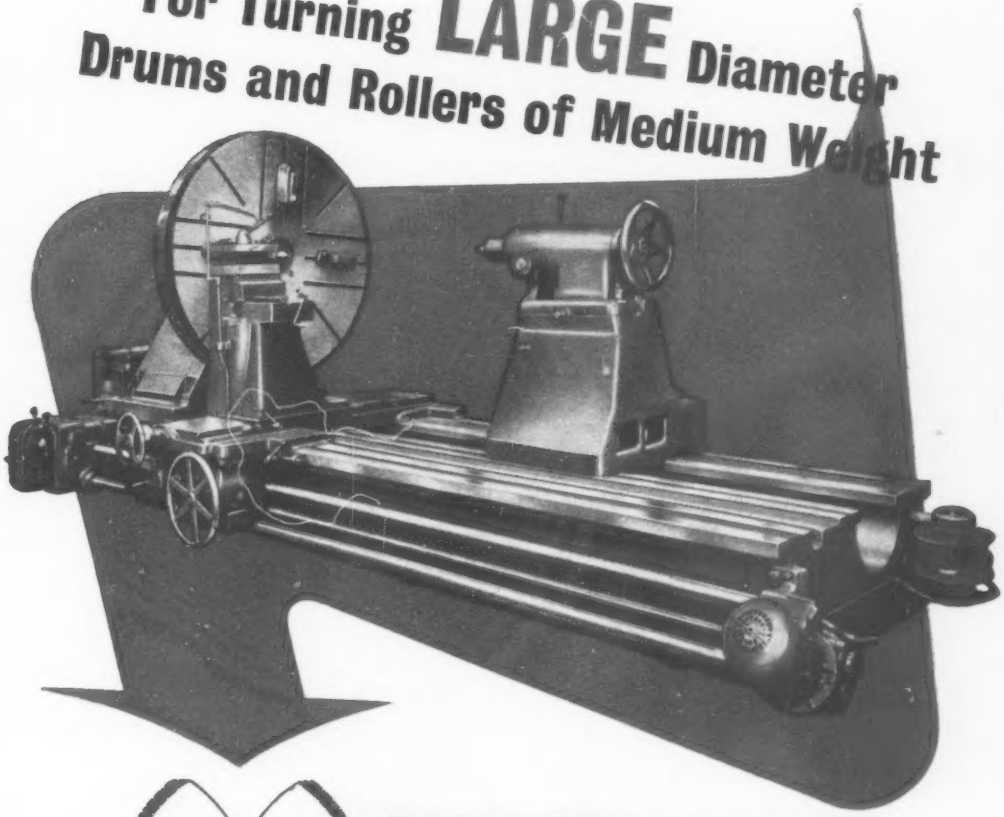

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**The O & S Drum Lathe incorporates all these features:**

- Up to 6′ swing over saddle
- Up to 25′ between centres
- 12 spindle speeds
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- Spindle bearings PB or Taper Roller
- 32 enclosed change feed and screw-cutting box
- Long lead cutting gear
- Quick power motion to saddle
- Power feed to compound top slide if required
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- 30 or 35 h.p. motor drive

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The O & S Range also includes: SS & SC lathes from 10¼ in. to 24 in. capacity; surfacing and boring lathes up to 96 in. swing; break lathes; axle lathes; rail-way carriage and wagon wheel lathes; axle journal turning and burnishing lathes; straightening presses.

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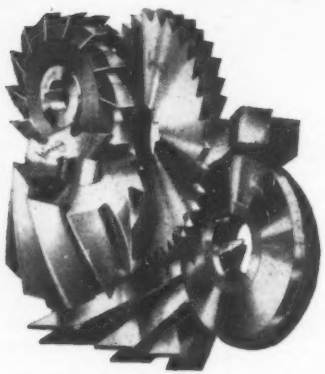

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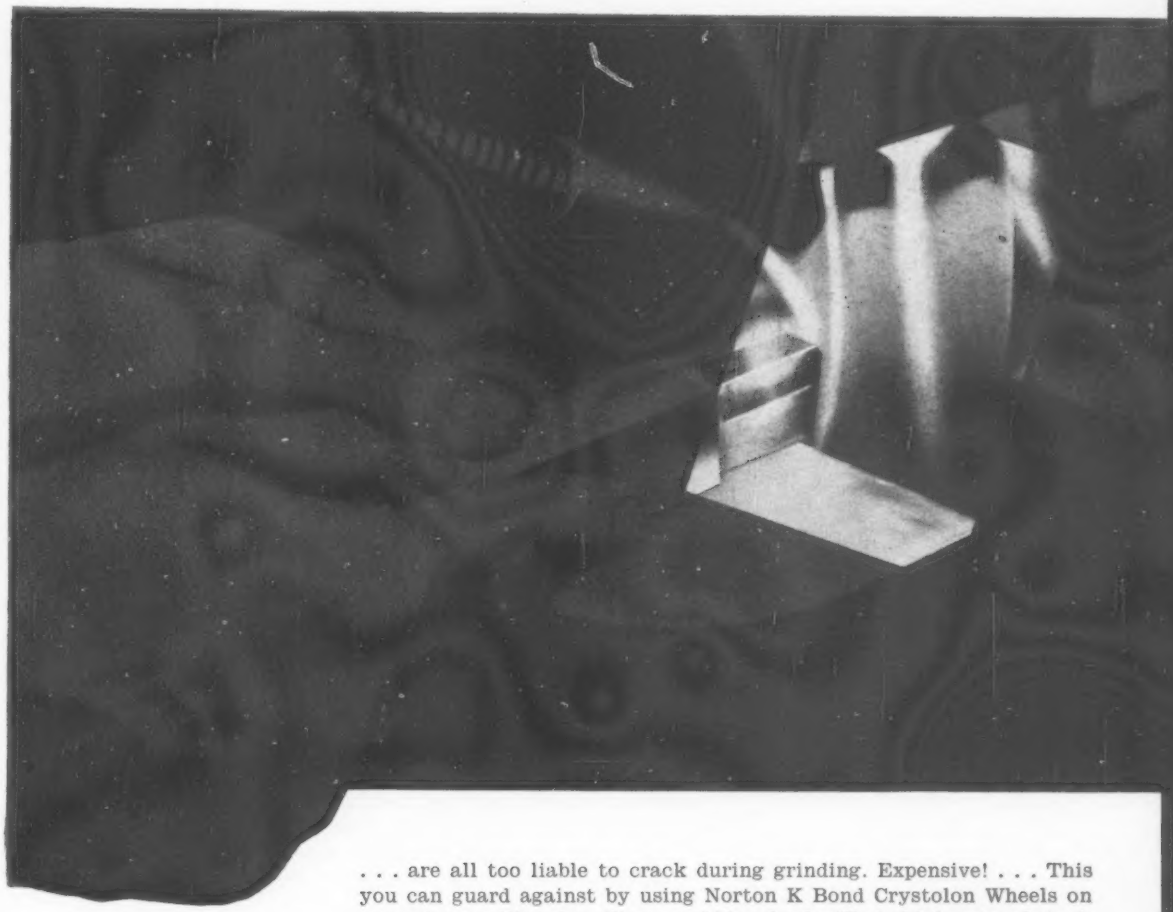

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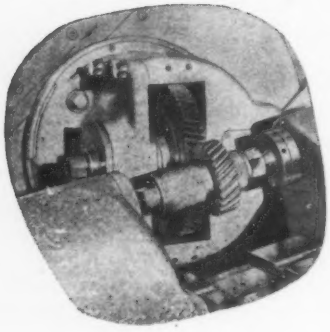
# S6H · S12H

## PRODUCTION GEAR SHAVING MACHINES



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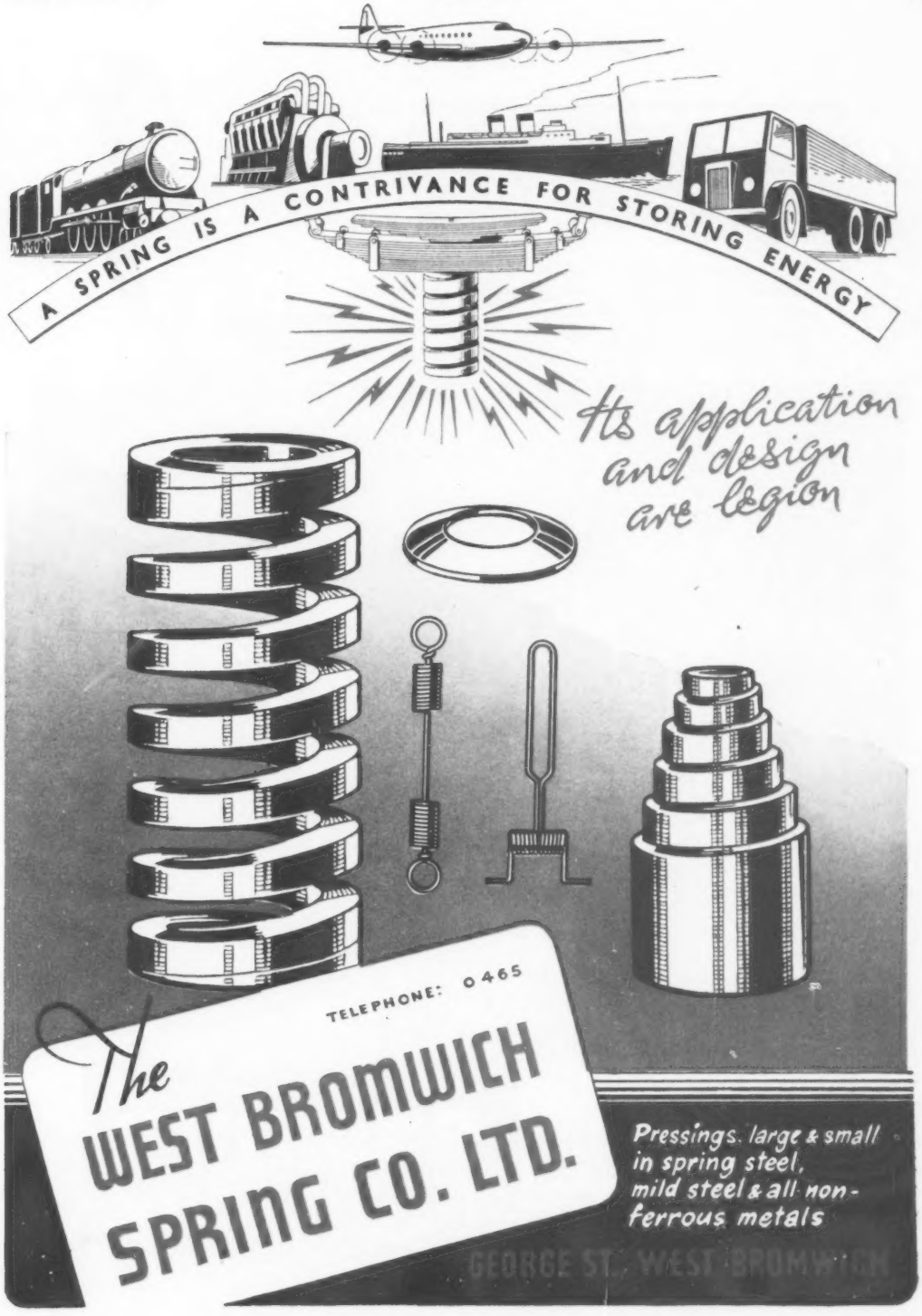
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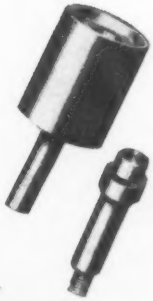

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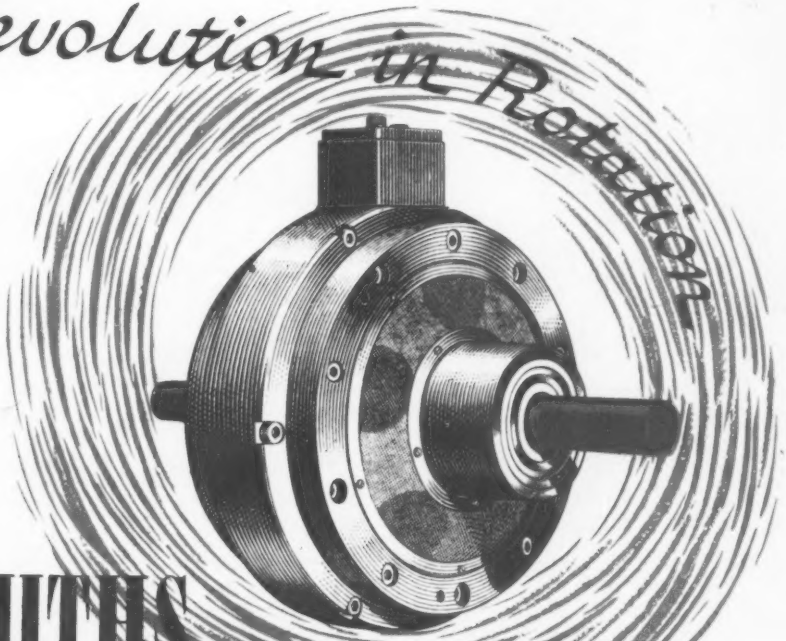

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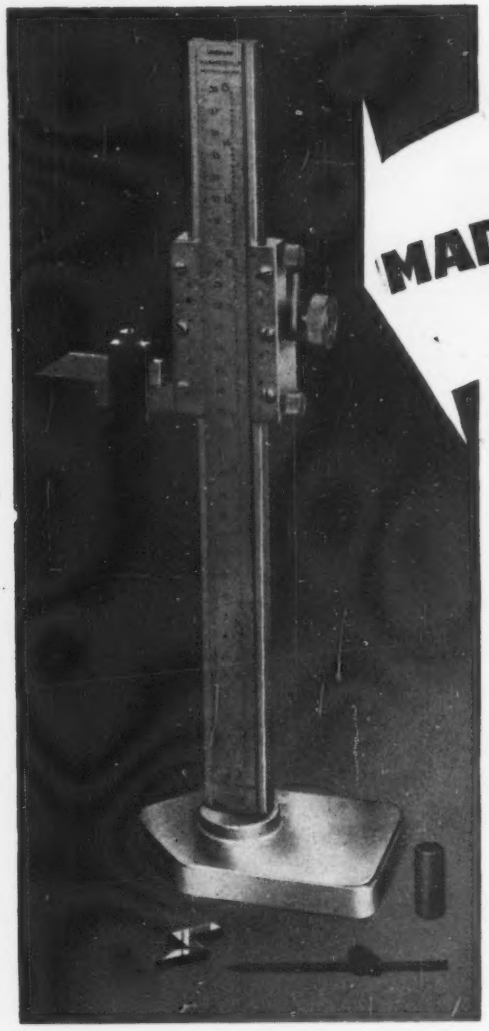

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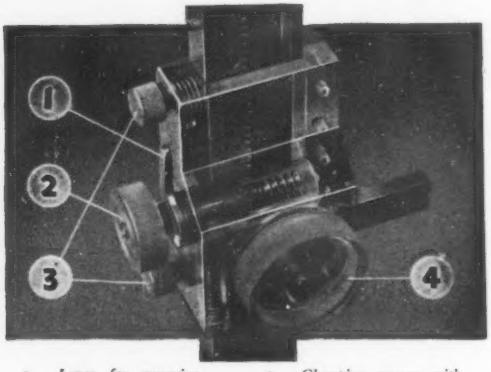


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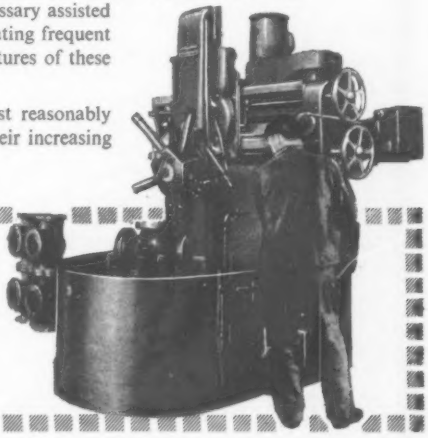

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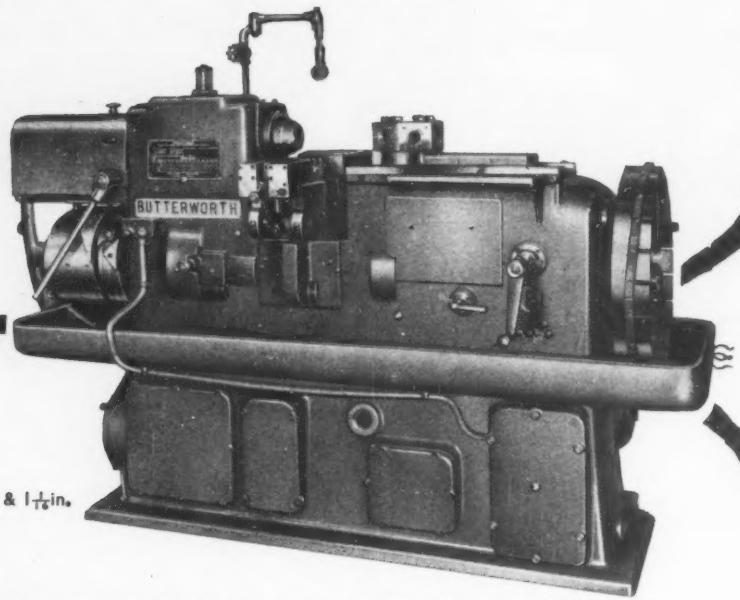


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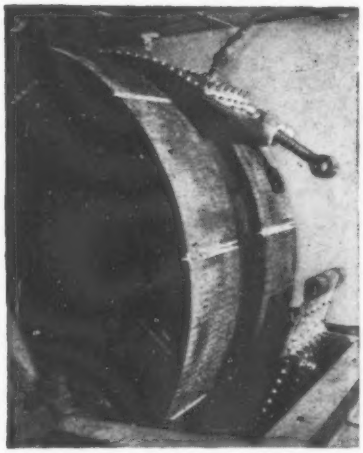

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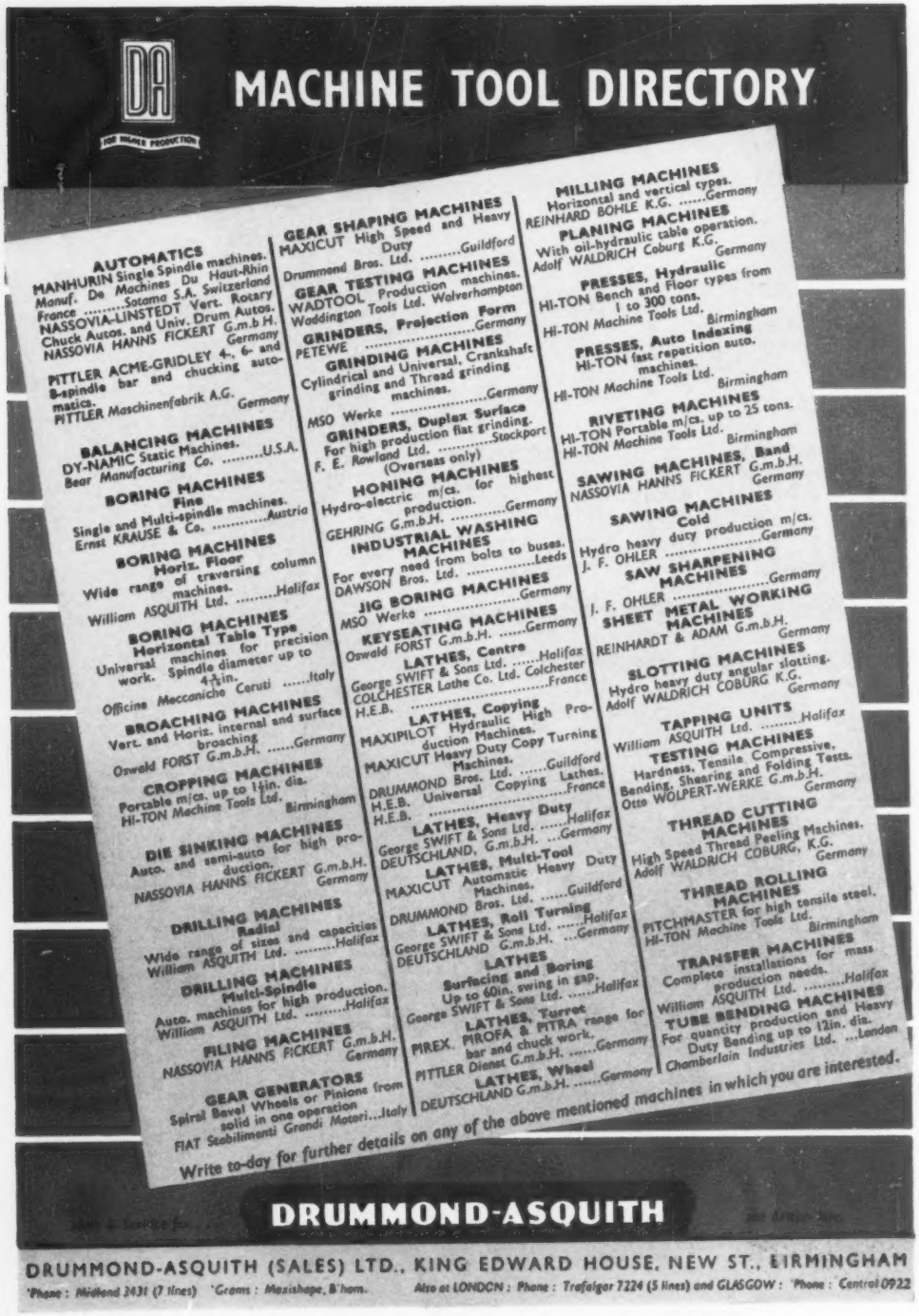
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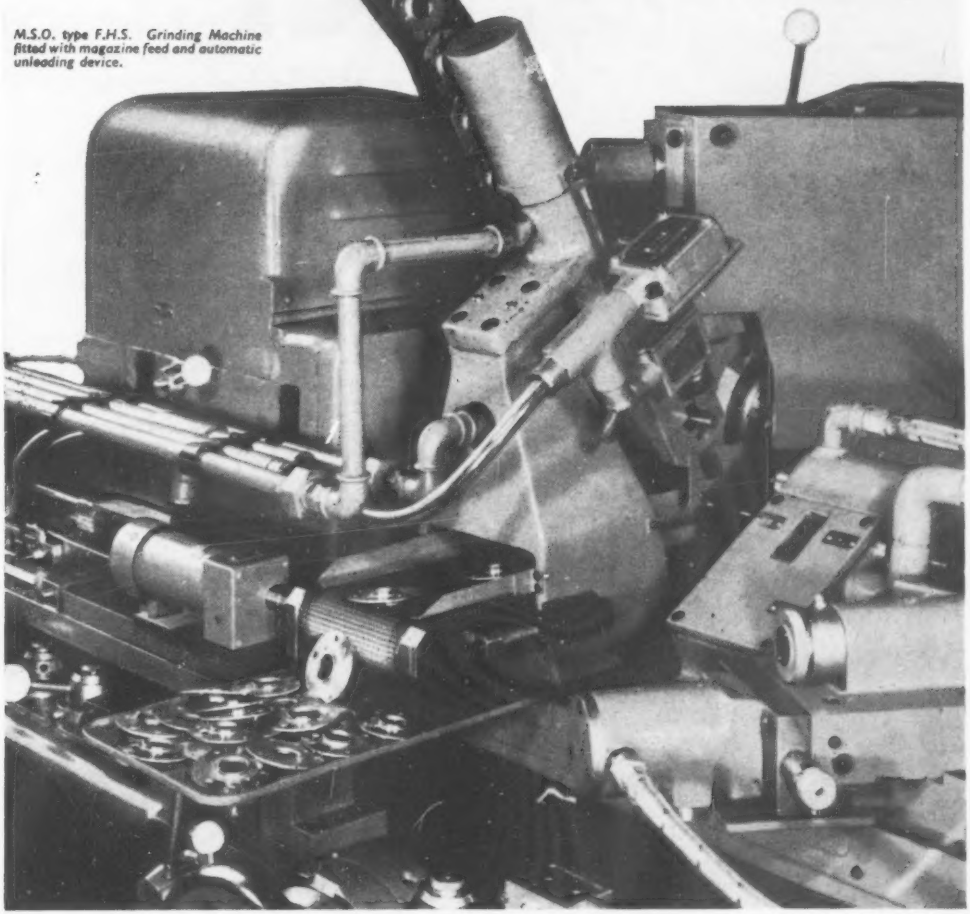

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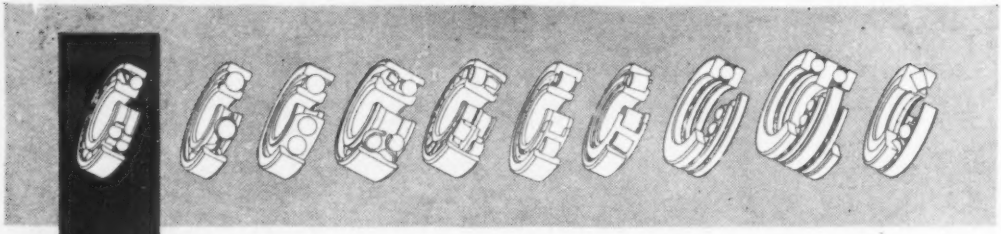

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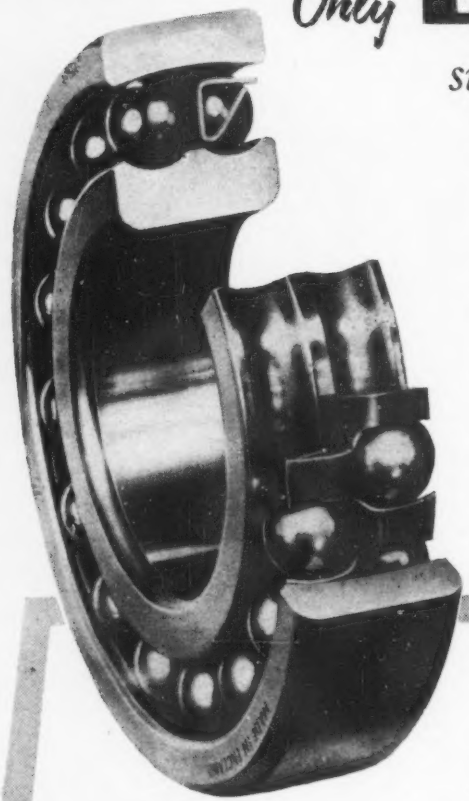

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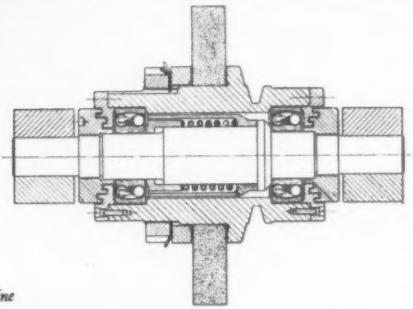

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# Abstracts of Principal Articles

## Machining Blades for Gas Turbine Units P. 400

In this second of a series of articles describing the practice at the works of B.R.D. Co., Ltd., who supply blades for gas turbines to most of the manufacturers of such units in this country, operations on stainless steel compressor stator blades are considered. Such blades are made from forgings which are received slightly oversize, and the initial operations are concerned with the machining of location surfaces on an adapted milling machine fitted with an additional spindle attachment, also a unit head for roller-box turning. A series of milling operations is then carried out on the root portion, before the blades are fitted into a face-plate fixture for finishing the root surfaces. Two interesting machines developed by the company for machining the root fillet radii on blades with flat and curved platform faces are next described, the movements of the blades relative to the milling cutters being controlled by cams. Finally, the finishing of the aerofoil surfaces is carried out on Jameson abrasive band type machines on which the blades are held in a fixture at the lower end of the ram of a vertical hydraulic cylinder. The abrasive band runs over a contoured die beneath this cylinder, and when the blade is forced down, the band is caused to assume the contours of the die so that the blade is machined to similar form. Finally, the blades are hand finished and polished before they are cut to the required overall length. (MACHINERY, 93—20/8/58.)

## Hermetal Double Bond Filled Epoxide Resin .....P. 413

Available in putty, cream, and pouring grades, Hermetal Double Bond is a versatile metallic synthetic material with numerous engineering applications, which is produced by the Kenilworth Manufacturing Co., Ltd. It can be used for filling and stopping, or as a basic constructional material in its own right. Its working and physical properties are described, and two examples of its use in the construction of special fixtures for the aircraft industry are discussed. Frequently, appreciable savings in time and cost can be effected, and a typical example is a pair of prototype fuse-box components. These parts were produced from the putty grade, with inexpensive wooden patterns, and plaster moulds. The cured material is harder than lead, and has machining properties generally similar to those of brass. It can readily be drilled, tapped, sawn and filed, is dimensionally stable, and is resistant to chemical attack. (MACHINERY, 93—20/8/58.)

## Producing Striking Levers on a Conomatic with an Eccentric-milling Attachment P. 418

At the works of Vauxhall Motors, Ltd., considerable economies in material and machining time are being obtained by producing striking levers from bar material of special section on a British-built, 3½-in., 6-spindle Conomatic. The tooling employed for this purpose includes a special eccentric-milling attachment at the fourth spindle position which serves to machine three off-set radii. This attachment is described and its action is explained. The eccentrically-mounted milling spindle is driven in synchronism with the machine spindle, and it may be noted that the cutters do not rotate about their axes, the milling action being obtained by relative movement between the teeth and work. (MACHINERY, 93—20/8/58.)

## Special-purpose Machines at the Skoda Motor Car Factory ..... P. 421

At the Skoda factory at Mlada-Boleslav, near Prague, Czechoslovakia, passenger cars are being produced at the rate of 150 per day. Much of the equipment employed for this purpose is to be replaced under a modernization programme, and various special-purpose unit-head machines of Czechoslovak design and construction have already been installed. Some representative machines of this type are here illustrated and briefly described, also a 6-station, in-line transfer machine for operations on cylinder heads. Attention is also drawn to certain of the plant provided in the sections of the factory, concerned with pressing, forging, and body welding, including a Czech-built 2,500-ton forging press, and an automatic multiple spot welder for window frames. Other multiple spot welders have been supplied by a Belgian company. A feature of the body department is a turntable installation with six jigs on which the main assembly operations are carried out. (MACHINERY, 93—20/8/58.)

## The Design and Application of the Wego Patent Optical Tool Goniometer.....P. 429

The Wego patent optical tool goniometer, of relatively simple design, can be employed for measuring a wide range of angles on cutting tools of different types. It consists of a microscope with a fixed graticule, graduated in ½-deg. increments, and a rotatable graticule with two crossed hair-lines. The microscope can be set in two directions at 90 deg., in the same plane, and a support for cutting tools can be rotated in that plane, also moved transversely. The angular and transverse displacements can be read from calibrated drums. In the support, there is a V-groove for mounting tools with shanks, and flat faces parallel and at right angles to the groove axis. Various set-ups for measuring the rake and clearance angles of milling cutters and other tools are described. (MACHINERY, 93—20/8/58.)

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## Contributions to MACHINERY

If you know of a more efficient way of designing a tool, gauge, fixture, or mechanism, machining or forming a metal component, heat treating, plating or enamelling, handling parts or material, building up an assembly, utilizing supplies, or laying out or organizing a department or a factory, send it to the Editor. Short comments upon published articles and letters on subjects concerning the metal-working industries are particularly welcome. Payment will be made for exclusive contributions.

# Iron and Steel

Despite the growing importance of various metals, the position still occupied by iron and steel in the economies of the more highly industrialized countries is so outstanding that the consumption of the ferrous metals per head of population may be taken as a fairly reliable indication of the standard of living that has been achieved. Similarly, changes in the production and utilization of iron and steel afford an important guide to the prevailing state of industrial activity. Apart from the " Iron Curtain " countries, the leading producers of crude steel are the U.S.A., Western Germany, the United Kingdom, France, and Japan, and it is of interest to examine the recent trend of output in each of these countries. For the U.S.A., which is by far the largest individual producer, the monthly average fell from 8,708,000 tons in 1955 to 8,573,000 tons in 1956, and 8,387,000 tons in 1957. During the first half of this year, however, the decline was very much more marked and the average figure from January to June was, 5,618,000 tons, or only 64·5 per cent of that achieved during the year 1955.

In Western Germany, which is the second most important producer, of the countries enumerated, the trend of output continued upwards until the end of the first quarter in 1958. The monthly average rose from 1,750,000 tons in 1955 to 1,902,000 tons in 1956, and 2,010,000 tons in 1957, and for the first half of this year, despite a setback in the second quarter, it amounted to 1,947,000 tons, which was still higher than the figure for the year 1956. Similarly, in the United Kingdom, average production increased from 1,649,000 tons in 1955 to 1,722,000 tons in 1956, and 1,808,000 in 1957. For the first half of this year the figure fell to 1,754,000 tons and this reduction was due to comparatively low outputs in May and June. The rise in French production, however, had not been interrupted up to the end of June (the latest month for which figures are available). Monthly average output increased from 1,033,000 tons in 1955, to, 1,099,000 tons in 1956, 1,156,000 tons in 1957, and 1,234,000 tons for the first half of this year.

For Japan, the only other country (outside the Iron Curtain) in which average output in 1957 exceeded 1,000,000 tons, the decline has been of much the same order as in Western Germany and the United Kingdom. After rising from 772,000 tons in 1955 to 911,000 tons in 1956, and 1,031,000 tons in 1957, the average fell in the first five months of this year to 957,000 tons (provisional).

Pig iron production, in general, has followed a similar trend. In the U.S.A. the monthly average from January to May was 3,801,000 compared with 5,903,000 for the full year 1957. For Western Germany, the corresponding figures were 1,413,000 (first six months) and 1,506,000; for the United Kingdom 1,128,000 and 1,190,000; and for France, 1,004,000 and 977,000.

It will be seen, therefore, that in the United Kingdom the fall in steel production, during the first half of the year, from the peak figure of 1957, was 54,000 tons per month, or approximately 3 per cent. For pig iron, the reduction in the monthly average was 62,000 tons, which represented 5·2 per cent. According to the published statistics, the transition from a shortage to a temporary surplus of iron and steel has not been accompanied by any marked changes in the level of stocks. As between the end of 1957 and the end of June, stocks of pig iron at steel works, steel foundries and blast furnaces showed a very slight decline, whereas stocks of crude steel at producers' works, up to the end of May showed a very small increase. In the first quarter, stocks of finished steel in the hands of users and merchants rose by 114,000 tons, but even so this amounted to an increase of only 2·5 per cent.

So far as our overseas trade is concerned, the changes in the ferrous metals supply position have had appreciably greater effects. During the period from January to June, our exports of iron and steel were valued at £95·5 million, whereas the total for the first half of 1957 was £109·9 million. In imports, the fall has been proportionately greater—from £38·9 million in the first half of 1957 to £30·6 million this year—and in this connection it may be noted that for the corresponding period of 1956 the figure was as high as £63·3 million.

As might be expected, in view of the abundant supplies of ferrous scrap at present available, imports have been drastically curtailed, and for the first six months of this year they amounted to no more than 52,400 tons as compared with

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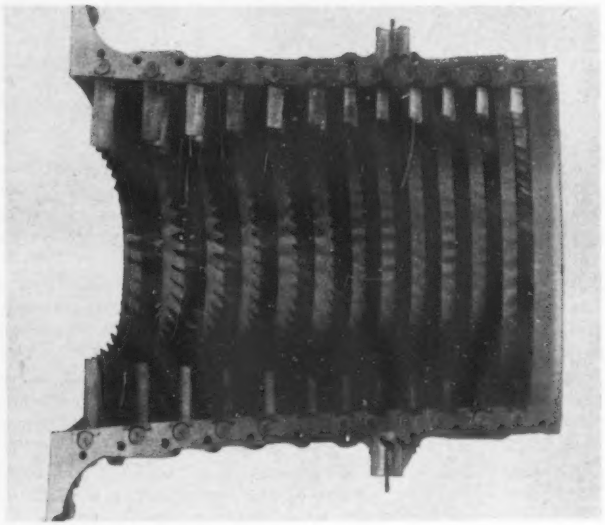

# Machining Blades for Gas Turbine Units

***Methods Employed by the B.R.D. Co., Ltd., Aldridge, Staffs.***

An article published in MACHINERY, 92/1082-9/5/58, gave brief details of the post-war history of the B.R.D. Co., Ltd.—a member of the Guest, Keen & Nettlefolds Group. In that article, some of the methods employed by the firm for the production of blades for gas turbine units from aluminium alloys, stainless steels, and Nimonic alloys were discussed, and a typical series of operations for machining precision-forged aluminium alloy blades was described. Here, attention is drawn to the procedure for machining those blades which cannot be satisfactorily forged to such close limits on the aerofoil portions as to require no further machining. Such blades are normally made from stainless steels for compressor applications, and from heat-resisting Nimonic alloys for turbine rotors, and the methods of machining are generally similar for either type of material.

Thus, the choice of method to be employed for a particular blade depends more on its shape and size than on the material from which it is made, although certain other considerations, such as the quantity required, the time available, and machine loading, also influence the decision. For the stainless steel compressor blades for the Proteus engines made by Bristol Aero-Engines, Ltd., considered in this article, the sequence of operations involves the use of milling machines and lathes for operations on the root portion and the Jameson aerofoil-generating abrasive-band type machine for finishing the blade. It may be noted, however, that the company also employs broaching and grinding methods for the root, especially where it is of fir-tree form, and a series of milling, grinding and polishing operations, performed on the well-known Ex-Cell-O range of machines, where they are considered to be more suitable, for finishing the blade portion. These latter methods, together with some more specialized techniques which have been recently developed, will form the subjects of further articles to be published later.

Most of the blades employed today in the compressor stators of gas turbine units are held in position by dovetail root portions which fit into corresponding grooves machined in the stator casing. A typical example of this design is afforded by the compressor stator half-casing for the Bristol Proteus turbo-prop engine, with its rows of blades assembled, as is shown in the heading illustration. Each of these blades has an approximately square root form, with inclined faces to engage the dovetail grooves in the casing. It will be appreciated that these faces are also curved to match the curvature of the casing grooves. It may be of interest to note that the Proteus 700 series of engines has now been approved by the Air Registration Board to run up to 1,600 hours between overhauls.

When all the blades in a particular row have been assembled, they are clamped in position by means of a washer with an eccentric hole, the outer blades of each row having shallow recesses machined in their under-sides, for this purpose. Since each blade abuts its neighbour, the opposing faces of the root must be machined at a suitable angle to provide the maximum clamping areas. With an alternative method of clamping, certain

of the blades in each row are forged with a long projection beneath the root, and this projection is machined to form a threaded stud. In the assembled compressor, this stud projects from a hole in the casing, and can be employed, with the aid of a nut, and in conjunction with other similar studs on blades in the same row, for clamping all the blades in place.

### MACHINING ROUGH-FORGED BLADES

Stainless steel blades are supplied to the machine shop in the heat-treated condition and are normally forged with an envelope of 0·040 in. minimum thickness on all surfaces. This amount of excess material is present on those blades which are produced in new or reconditioned dies, but since die wear is comparatively rapid, the metal to be removed may be slightly thicker. Details of the procedure for progressing work through the shops were given in the previous article, and it is here sufficient to note that the blades are released in batches, usually of 50. They are accompanied by cards giving operation details, with spaces for stamping by an inspector when each operation has been performed, to acceptable standards, on all the blades in a batch. The first operations carried out are designed to provide locating surfaces, particularly on the pips forged at each end of the blank for that purpose, for positioning during subsequent operations.

Usually, the leading edge of the aerofoil portion of the blade is first machined, the component being located in floating vees and clamped on the aerofoil portion by cam-operated cast zinc alloy clamping pads, which conform approximately to the curved surfaces. A ½-in. diameter end-milling or similar cutter is then employed to remove up to 0·060 in. from the leading edge of the blade, at a single pass. Two grooves are next machined on the side of the root adjacent to the concave side of the aerofoil and one on the opposite side, and the pip at the end of the aerofoil portion is turned, at a single set-up on a converted milling machine. A general view of the Somua [Machine Tool Sales (London), Ltd.] horizontal milling machine used for these combined operations is given in Fig. 1, from which it may be seen that an attachment is fitted to the machine column to carry an additional milling cutter.

The attachment is of massive proportions, so that the spindles are adequately supported against the cutting forces tending to spring them apart. A short arbor, fitted to the milling machine spindle, projects through the attachment and carries a single cutter for the upper groove in the blade root. On this arbor is also mounted a spur gear, the teeth of which mesh with those of a similar gear on a shaft *A*, at the left. Integral with this second gear is a roller chain sprocket from which the drive is transmitted to another sprocket on the spindle of the attachment. This spindle is fitted with two cutters and is driven in an anti-clockwise direction, which is opposite to that of the machine spindle.

To enable blades with a variety of root widths to be machined, the lower spindle housing can be adjusted vertically to the required spacing. A

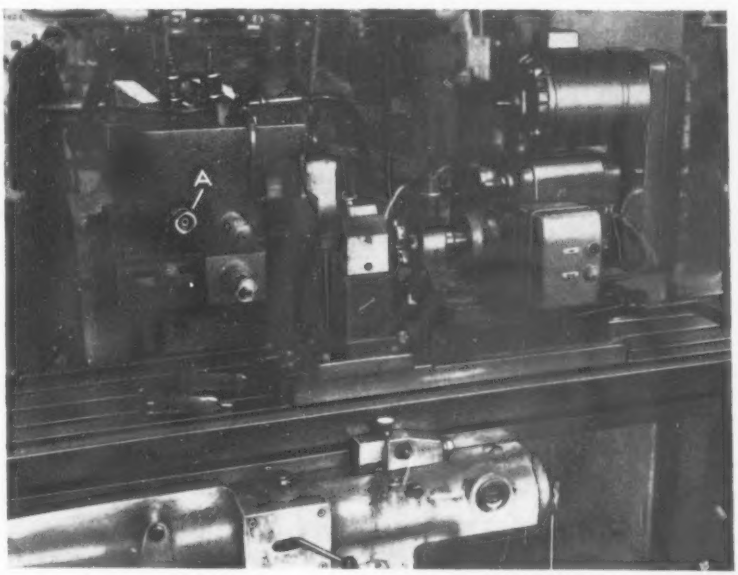


**Fig. 1. General View of a Somua Horizontal Milling Machine Fitted with a 2-spindle Milling Attachment and a Delta-Milwaukee Air-hydraulic Unit Drill Head for Preliminary Operations on Stator Blades**

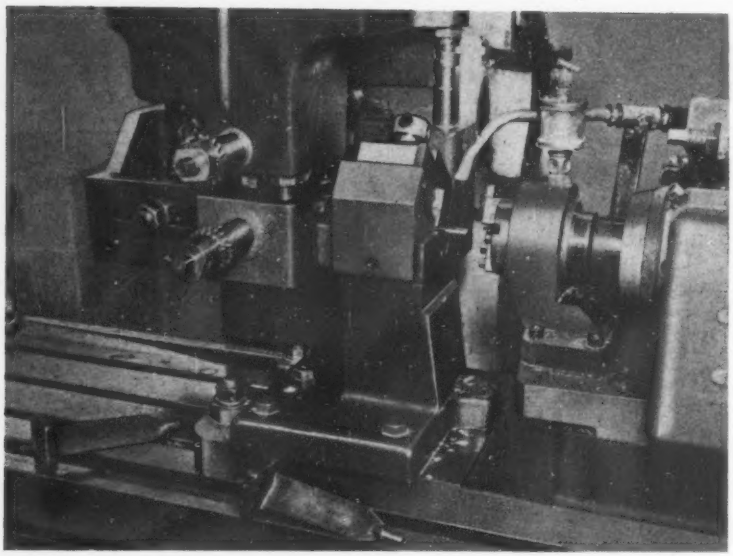

**Fig. 2. In this Close-up of the Attachments on the Somua Machine, Details of the Roller Box Turning Tool, the Grooving Cutters, and the Fixture for Holding the Blade, Can be Seen**

chain-tensioning sprocket, adjustable for position along a slotted bar, is provided at the left. All three cutters, which are made from high-speed steel, are of similar design, and each has 20 teeth, ground to an angle of 45 deg. to produce the V-shaped grooves required in the blade shown. The cutters are driven at a speed of 80 r.p.m. and the table feed rate is ½ in. per min. After the fixture has been loaded, the machine cycle is started by moving the lever in the foreground in Fig. 1. At the same time, the operator depresses the starting push-button of the small Delta-Milwaukee (Gaston E. Marbaix, Ltd.) air-hydraulic unit head mounted on the table at the right-hand side of the fixture.

The spindle of this head is driven from a motor, mounted above, through V-belts, at a speed of 800 r.p.m., and is fitted with a special roller-box turning head of the company's own design. This box incorporates two rollers and a single tool of high-speed steel which is employed to turn the forged pip on the end of the aerofoil portion of the blade to the required diameter, to suit the locating arrangements in the remainder of the fixtures in the line. The cycle of the head is automatic, after the button has been pressed, and the tool is fed towards the work until the pip has been turned to the pre-set length, determined by a stop, after which the direction of movement is reversed and the head is withdrawn.

A close-up view of the machine, in Fig. 2, shows some details of the clamping arrangements, which are comparatively simple. The fixture has a cast base with an upright portion, in which a slot is machined at an angle of about 45 deg. In this slot, there is a pad which conforms approximately to the contours of the concave side of the blade, the latter being loaded with the leading edge

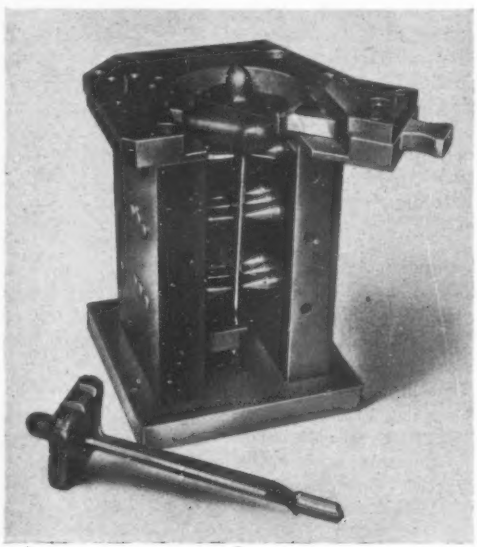

**Fig. 3. After Milling the Locating V-grooves and Turning the Pip at the End of the Aerofoil Portion, the Blades are Checked in this Fixture to Ensure that the Location Surfaces are Correctly Positioned, Relative to the Aerofoil**

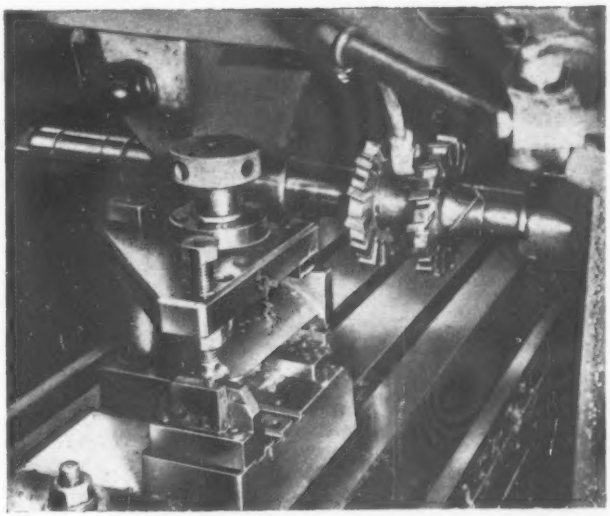

**Fig. 4. Straddle Milling the Sides of the Root is Performed at this Set-up on a Werner Horizontal Milling Machine, with a Pair of Galtona Cutters Having Inserted High-speed Steel Blades**

towards the rear of the machine. The leading edge rests in contact with locating surfaces at one side of the slot, and the work is positioned longitudinally by the surface of the root portion, on the blade side, which is pressed against a projection at that end of the support pad. Clamping pressure is then applied to the aerofoil portion by means of another pad, with contours which match the convex side. This pad is moved down by means of a screw in a bridge member above the fixture slot, and tightened with the aid of a tommy bar, which is inserted in holes in the head of the screw. Examples of blade forgings before and after this combined operation are also seen in Fig. 2.

For checking the positions of the location surfaces relative to the aerofoil portion of the blade, the fixture seen in Fig. 3 is employed. In this fixture, the lower end of the blade is located by the cylindrical pip which enters a slot in the end of a bar, and the platform faces rest on top of the two side columns. The root end of the blade is positioned by means of two sliding plungers, of rectangular section, which have pointed 90-deg. projections at their inner ends, to engage the machined grooves. Plungers in the side and rear walls of the fixture can then be pushed into contact with the blade surfaces to determine their positions relative to the locating faces. Should the position of the aerofoil depart from that which it should occupy if the removal of approximately equal amounts of material from the forging surfaces is to give an acceptable blade, the position of the fixture relative to the cutters, on the machine in Fig. 1, can be adjusted. Although the fixture is primarily employed during setting up, it is also useful for checking the accuracy of the blade forgings.

After the location surfaces have been milled, the blades are machined to a standard overall length, with a flat face at each end. This operation is performed on a battery of Werner (Rockwell Machine Tool Co., Ltd.) horizontal milling machines, fitted with 7-in. diameter high-speed steel cutters, with close-pitched, staggered teeth. The blade is located and clamped by the grooves in the root sides and the cylindrical pip, and is positioned end-wise from the platform face adjacent to the aerofoil. This operation is followed by straddle-milling the ungrooved side faces of the root end, to remove the lobes produced during the forging operation, at the set-up seen in Fig. 4, also on Werner machines. In the fixture shown, the blade rests on two projections which engage in the two grooves on one side, and in a V-location at the aerofoil end, and is positioned end-wise from the platform face.

Clamping pressure is applied to the root end of the blade, also to the cylindrical pip, by means of a central screw in the triangular plate. Each of the two 5-in. diameter Galtona (Richard Lloyd, Ltd.) milling cutters has 14 inserted blades of high-speed steel and is driven at a speed of 48 r.p.m. The table feed is 1 in. per min. and the amount of material removed varies up to $\frac{3}{8}$ in. A coolant mixture of soluble oil and water is employed. A clearance pocket is next milled in the flat underside of certain blades on vertical milling machines of the type shown in the close-up view, Fig. 5. On this Heller FV 140 (Wickman, Ltd.) machine, the fixture provides for holding two blades with the faces to be machined opposite each other, so that both can be milled with the same cutter, simultaneously.

Each forging is positioned at the root end by means of the two grooves which engage projections on a horizontal surface, and at the opposite end by the cylindrical pip. The latter is held in a V-location, and its end surface is pressed against a stop on the fixture for end-wise positioning. A

**Fig. 5. In Some Instances, Pockets are Milled in the Under-side of the Root, on Two Blades at Once, with this Set-up on a Heller FV 140 Vertical Milling Machine**

thumb-screw is then tightened to hold the cylindrical pip and the root end is secured by a simple lever-type clamp. The machine spindle is fitted with a cutter of $\frac{1}{8}$ in. diameter, with six helical teeth, and is driven at 224 r.p.m. For the milling operation, the table is fed vertically upwards, at the rate of 0·16 in. per min., for a distance which varies with the depth of the pocket and is controlled by table stops.

Since the stator blades are to be fitted into annular grooves in the casing, the sides of the root portion which engage the groove, also the bottom surface, must be machined to a matching curved shape. This operation is performed in several stages on specially adapted Hasse & Wrede (Benrath Machine Tools, Ltd.) and Ward, Haggas & Smith lathes. A typical set-up on one of the latter machines is shown in Fig. 6, and it will be observed that the spindle is fitted with a large face-plate fixture on which a number of blades is held in positions similar to those which they will eventually occupy in the stator casing. Each blade is again located by the V-grooves and cylindrical pip, and the latter rests in a vee near the face-plate centre and is secured, very lightly initially, by a lever-type clamp. The end of the pip is employed for radial positioning.

At the periphery of the face-plate, there is a hardened locating and clamping element, with the appropriate V-projections, for each side of each blade. Between the clamping elements for adjacent blades, there is a wedge-shaped pressure pad which can be moved towards the face-plate centre by tightening a socket screw. The pad then pushes the clamping elements apart, with the result that pressure is applied to the opposing sides of the roots of the two blades.

For the first stage of the turning operation, the turret tool-holder on the front cross-slide is employed. This turret is equipped with two carbide-tipped tools, which serve to machine chamfers at at the specified angle on the outer edges of the root

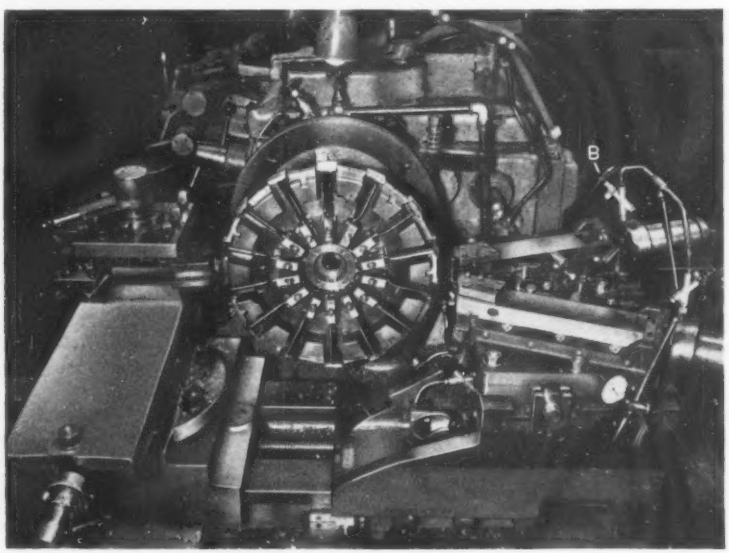


**Fig. 6. Finishing Operations on Two Sides and the Under-surface of the Blade Root are Performed on this Ward, Haggas & Smith Lathe, Fitted with a Face-plate Fixture which Holds 14 Blades**

portions. The chamfers can be clearly seen on the two examples of blades which have been machined on this lathe, in the foreground in Fig. 7. For this and the following operations, the speed is 31 r.p.m., and the tools are fed in very carefully by hand, to a depth stop. The second stage provides for rough-turning the outside surfaces of the blades to produce the curvature required, and is carried out with a single tool in the same turret holder. At the third stage, the dovetail surfaces of the roots are semi-finish machined, on each side in succession, with the turret in the third position.

Finish turning of the outside surfaces is next carried out with a tool in the front turret, approximately 0·010 in. being removed. For the subsequent operation of finishing the root dovetail surfaces, the equipment fitted to the rear of the cross-slide is employed. This equipment comprises two slide units carried on a single base, which is supported on the saddle ways and can be moved towards and away from the work by means of the cross-slide screw. Each tool slide is fitted with dovetail ways which engage grooves of similar section on the base casting, and screws are provided for lateral adjustment. At their outer ends, the tool slides are connected to the rams of hydraulic cylinders whereby they are fed towards and away from the work. Most of the hydraulic cylinders and valves employed for this and other equipment here described have been adapted from standard proprietary ranges, including flow control valves which are fitted in the lines leading to the front of the piston in each cylinder.

The body of each valve is provided with a graduated disc and the end of the adjustment spindle with a needle pointer, as indicated at *B* in Fig. 6, and the valves are employed to regulate the flow of hydraulic fluid out of the cylinders during their cutting strokes, the pointers being set to the required feed rate marked on the discs. For turning the dovetails on the blades, the saddle is moved up to a position at which a predetermined reading is obtained on a dial gauge, and locked in place. In this connection, it may be noted that all the preliminary work of setting the slides and tools for a particular blade is carried out with the aid of a replica of that blade which is mounted in the face-plate fixture. The tool slides at the rear of the cross-slide are then set at the required distance apart for the beginning of the operation, again by means of dial indicators, one of which is seen, held in place by an Eclipse (James Neill & Co. (Sheffield), Ltd.) magnetic base unit, at the right in Fig. 6.

The direction of rotation of the spindle is reversed for the operations performed with the rear-mounted tools, and the latter are fed forward

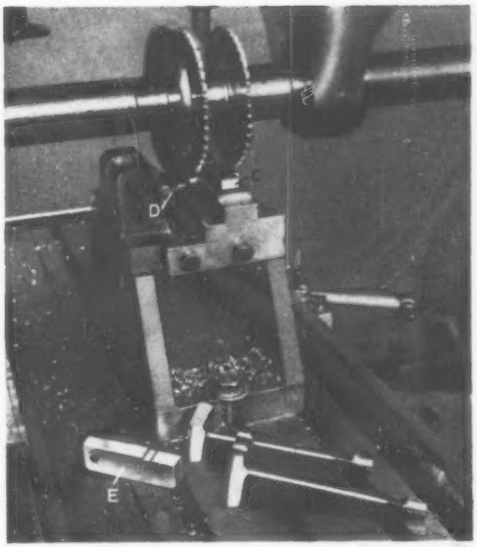


**Fig. 7. Set-up on a Werner Horizontal Milling Machine for the Removal of the Root Material Containing the Locating V-grooves. The Table is Fed Vertically Upwards to Carry the Blade Between the Cutters**

hydraulically, under the control of a valve at one end of the bed on the operator's side of the machine, a light cut of about 0·005 in. being taken by each tool. Dial indicator and other gauges are employed to check the width across the faces, also the position of the blade aerofoil relative to the root, during the operation, and a light finishing cut is applied to remove 0·001 to 0·002 in. Finally, the spindle rotation is again reversed and with the compound rest of the front tool-holder set at the required angle, the outer chamfers are finished in succession. The series of operations is complicated and must be performed by a skilled operator, who normally requires about 45 min. to complete the turning of the 14 blades accommodated in the fixture at each loading.

With the dovetail sides of the root machined in this manner, the blades can be located from the curved surfaces for subsequent operations, so that it is now possible to remove material from the sides containing the locating grooves. This operation is performed, with the set-up shown in Fig. 7, on a Werner horizontal milling machine, the arbor of which is fitted with a pair of high-speed steel cutters of 5 in. diameter by $\frac{3}{16}$ in. width, each with

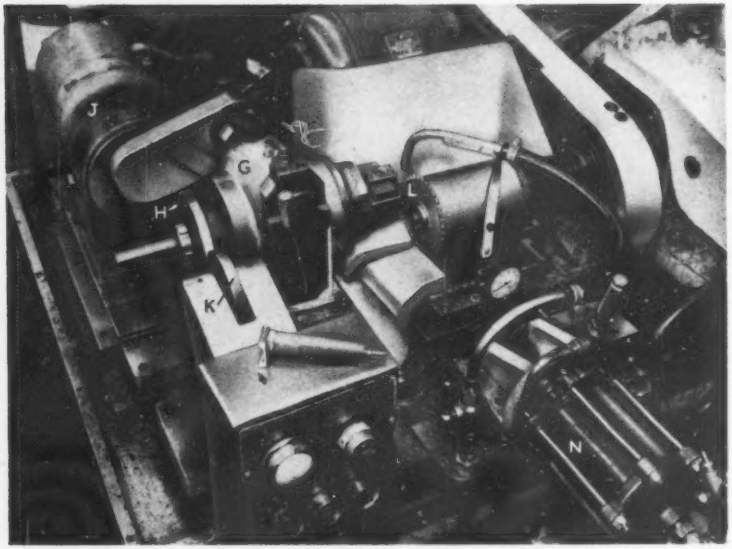


**Fig. 8. View, from the Operator's Position, of One of the Special Machines Designed by the Company for Machining the Root Platform and the Radii Between the Platform and the Aerofoil Surfaces**

40 close-pitched teeth. These cutters are driven at a speed of 45 r.p.m., and the table carrying the work is fed vertically upwards at the rate of $\frac{1}{8}$ in. per min. In the fixture, the blade is suspended vertically, and the dovetail surfaces rest on clamping blocks with matching curvature. One of these blocks, on the near side of the fixture in Fig. 7, is fixed and the other is movable horizontally, by means of a screw at the far side.

To the top of each block is secured a horizontal bar, as at *C*, which projects above the blade root, and when the sliding block is advanced, the blade is forced upwards, by the action of the inclined surfaces of the blocks against those of the root, until further movement is prevented by these bars, and the blade is thus securely clamped. For positioning the blade between the two clamping members, it is pressed against a spring-loaded swinging stop *D*, pivoted in a slot on one side of the fixture. The end of this stop has V-surfaces to engage those on the side of the root, and its pivot axis is slightly above the outer end, in the free position. A wheel on the machine arbor comes into contact with the stop, as the table is fed upwards, and pushes it down, clear of the cutters. The gauge *E*, which has "go" and "not go" steps in the face, can be applied to the sides of the fixed clamping block of the fixture to determine whether the correct amount of material has been removed from the root surfaces.

After the milling operation, the sides of the blades which are in contact with those of adjacent blades in the stator case grooves, are finish ground to the required angles, usually of 2 to 4 deg. to the aerofoil axis, on each side. This operation is performed on one of the Ex-Cell-O root grinding machines described in the previous article, which is equipped with twin wheels mounted on vertical axes. The blade is held in a box-type fixture, which is moved hydraulically on a slide between the wheels, and the latter are dressed, to the angle required, by means of a built-in attachment. The wheels are then fed towards the work automatically, after each reciprocation of the slide, until the correct size has been obtained. Some blades, for example those with the fixing studs, mentioned earlier, and those adjacent to them in the stator case groove, are provided with angles of about 45 deg. so that the clamping pressure applied by tightening the nut on the stud may be more effectively applied to the remainder of the blades in the groove. These angular faces are usually finished on a surface grinder, with the blade held in a simple fixture.

## MACHINING THE ROOT FILLET RADIUS

One of the more difficult operations in the production of turbine blades is the machining of the radius at the junction between the aerofoil surfaces and the root platform. It is important that these surfaces should blend smoothly so that there are no discontinuities of form which might disturb the gas flow over the blade. Until recently, it has not been possible to perform this operation on a standard machine tool, although a hydraulic copy-milling attachment is now being successfully employed, as will be described in a later article.

Prior to the adoption of this attachment, the company undertook a considerable amount of development work and have designed and built special machines of two slightly different types, for milling the platform face and the adjacent radius. A view of one of these special machines is given in Fig. 8. It is of duplex type, and only one half is shown, the other half, to the right, being identical.

Both portions of the machine are mounted on a common base plate, and for this purpose a surface table measuring 6 by 4 ft., supplied by Windley Bros., Ltd., was employed. The table is supported on a framework of angle- and channel-section steel which also carries certain other equipment. At the left-hand side of the table there is a housing, *G*, for a horizontal spindle, on the outer end of which a cam *H* is mounted. This cam is designed to suit the contours of the aerofoil on the blade to be machined. Another view of the same machine, given in Fig. 9, shows the inner end of the spindle, which carries a simple fixture to hold the blade by the root. Location is taken from two adjacent finished surfaces, and the blade is clamped against two fixed faces by jaws, which are tightened by means of socket screws.

The spindle runs at a speed of about 4 r.p.m. and is driven through roller chain, and a worm and wheel within the housing, from the Coventry geared motor unit *J*, which incorporates a ½-h.p. motor. Both the spindle housing and the driving unit are mounted on a slide which is guided in ways secured to the table surface, and this slide is loaded, by means of an air cylinder at the far end, so that the cam *H* is held in contact with the surface of a roller *K*, carried in a fixed bracket at the front of the machine. Thus, as the spindle turns, the blade is moved sideways so that the surfaces of the theoretical aerofoil are maintained continuously at a fixed distance from the axis of the cutter *L*, Fig. 8. Several different types of cutter are employed for the work, and that shown is a Coromant (Sandvik Swedish Steels, Ltd.) with 34 teeth tipped with tungsten carbide. The solid high-speed steel cutters formerly used had a very short life on this operation, and those with carbide-tipped teeth are therefore preferred.

Cutter diameter is not important so long as it bears the correct relationship to the cam *H*, and the roller *K*, but it must be sufficiently small to suit the smallest radius on the concave side of the particular blade to be machined. Radii of between 0·1 and 0·13 in. are normally specified at the position where the aerofoil joins the root portion of the blade, and the cutter is ground as required, that shown having a radius of 0·125 in. The cutter spindle is driven at a speed of 650 r.p.m. by means of a Brook 1½-h.p. electric motor, through a roller chain, and it may here be observed that several covers have been removed to enable details of the machine to be more clearly shown. Both the cutter spindle housing and its driving motor are also carried on a slide, which can move on the table surface in a direction parallel to that of the first-mentioned slide, and this motion is derived from the cylinder *N*, fixed to a bracket at the front edge of the table.

This cylinder forms part of a closed-circuit hydraulic system and is connected, at both ends, to another cylinder of similar dimensions beneath the table. The ram of this second cylinder is coupled to that of a third cylinder, with which it

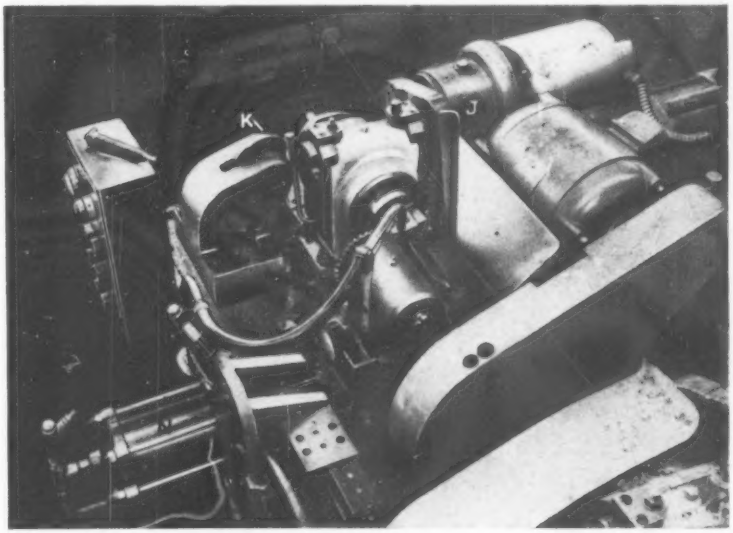


**Fig. 9. Another View of the Machine in Fig. 8, Showing Details of the Blade-holder in which the Blade Root is Clamped in Two Directions. The Work-spindle is Driven at a Speed of 4 r.p.m.**

is arranged in tandem, and the third cylinder is connected, through a control valve, to the shop air supply. When air is admitted to one side of the piston in this third cylinder, the movement of the piston is transmitted directly to the piston of the second cylinder. Oil displaced in this manner is passed to one end of the cylinder *N*, causing the slide to move towards or away from the work. In entering or leaving the cylinder *N*, the oil passes through an adjustable restrictor valve, so that the feed rate, and the speed at which the slide is retracted from the work when the operation has been completed, can both be easily adjusted.

After the blade has been loaded and a button on the panel at the left has been pressed, the machine operates on an entirely automatic cycle. The cutter slide starts to feed towards the blade at a very slow rate, which is necessary because several of the teeth are in contact with the work when the concave side of the aerofoil is turned towards the cutter. When the head has been fed to the full depth of about ¾ in., it comes into contact with a stop which prevents further movement, and at the same time a limit switch is operated. This switch starts an automatic timing mechanism which runs for a period of 3 sec. with the cutter slide stationary but with the spindles still turning, to provide for any spring in the work. At the end of this period, the mechanism operates a solenoid valve, which reverses the direction of the air supply to the feed cylinder beneath the table so that the cutter slide is retracted. When the slide reaches the fully withdrawn position, it operates another micro-switch to cut off the current to the spindle driving motors, and the machine can then be reloaded. The cycle time is about 5½ min.

It will be appreciated that since the cutter on this machine is fed at 90 deg. to the aerofoil axis, and machines the so-called platform face of the root, this platform face must necessarily be flat. Most stator blades in current production have flat platform surfaces, but for many rotor blades, convex faces which have convex curvature in one direction, and blend into the fillet radii, are specified. For machining such faces, also a portion of the aerofoil, another type of machine has been developed, a general view of which, taken from the rear, is given in Fig. 10. In this instance, however, it is set up for operations on a flat-platform blade. On this machine, there is a long double slide unit, and the upper slide *A* carries the spindle-driving motor *B*, of 1 h.p., at the left-hand end. Drive from this motor is transmitted through a roller chain and a small reduction unit to a horizontal shaft, which passes through a worm reduction gear *C* on the upper slide. The worm-wheel shaft of this unit carries a flat plate *D*, to which a special cam is secured when curved platform faces are to be machined.

Beyond the worm gear unit *C*, the driving shaft extends to another worm gear housing which provides the final drive to the work spindle. The latter is equipped with a holder at the front end, similar to that described above, and has an extension at the rear, on which is mounted a cam *E*, for controlling the form of the aerofoil at the root end, as before. The upper slide *A* is loaded, by means of the air cylinder *F* at the left-hand end, so that the cam *E* is held in contact with a roller in a housing on the right-hand end of the lower slide. Consequently, the work spindle and the roller can both be moved sideways, by means of the lower slide, while the cam remains in contact with the roller. This arrangement enables the work to be fed towards the cutter

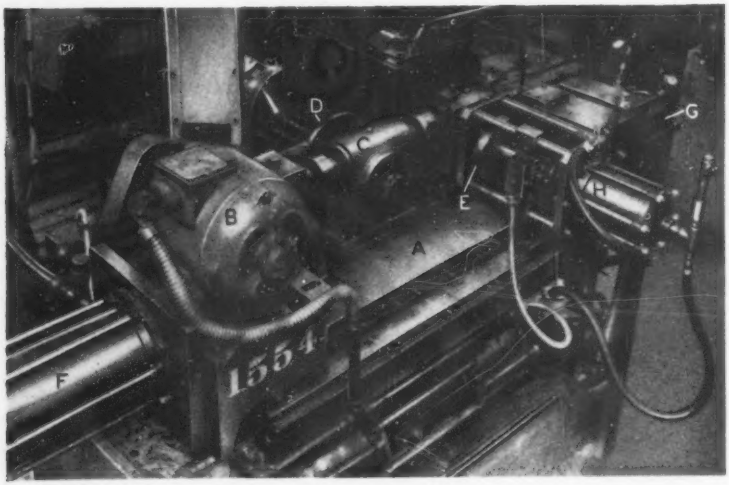


**Fig. 10. On this Machine, which is a Development of that Shown in Fig. 8, Blades having Both Flat and Curved Platforms can be Machined, also a Portion of the Aerofoil Adjacent to the Root**

by means of the hydraulic cylinder *G*, which forms part of a close-circuit air-actuated system, similar to that employed on the previous machine.

Four horizontal posts on the rear of the work spindle housing support a cylinder *H*, which is connected to another closed-circuit hydraulic system, the cylinders for both systems being housed beneath the machine table. The ram of the cylinder *H* is connected to the end of the work spindle, which is so arranged that it may be moved axially, and when the work has been fully engaged with the cutter, this cylinder serves to apply feed in a direction parallel with the cutter axis so that the aerofoil portion of the blade is machined for a short distance. The length of aerofoil thus produced is usually ½ to ¾ in., and a roller of suitable width is fitted so that contact with the cam *E* is maintained. The removal of material at this position considerably simplifies later operations on the aerofoil portions of blades of certain designs.

A close-up view of the work holder and the cutter spindle is given in Fig. 11, and the housing for this spindle is mounted on a slide which is arranged at 90 deg. to the double slide previously described. This slide is loaded, by an air cylinder at the front of the machine, against a stop, so that the cutter is held constantly in one position, when flat platform blades are being machined. For machining blades with curved platforms a bracket carrying a roller is fitted to the cutter slide and the roller is then held in contact with a cam secured to the plate *D*, Fig. 10. Thus, as the work turns and is fed towards the cutter, the latter is oscillated slightly to produce the curved surface required, until the cutter has been fully engaged. The cylinder *H* is then energized to feed the blade axially for machining part of the aerofoil portion.

Drive to the cutter spindle is taken from an All-speeds motor unit incorporating a Kopp Variator which provides a steplessly-variable range of speeds. This unit is installed beneath the table, the drive being transmitted through two roller chains. The cutter shown, which has a diameter of about 5 in., is driven at 480 r.p.m., to provide a cutting speed of about 600 ft. per min., and has 40 carbide-tipped teeth. The work is driven at 5 r.p.m., and the machine cycle is again automatic after it has been started by means of a push-button, the various movements of the slides being controlled by limit switches and solenoid-operated air valves. Normally, the cycle time is about 10 min. On some forgings, there is an excessive amount of material at the position of the fillet radius, and a roughing operation is then performed. Such an operation has been carried out on the blade seen in the holder in Fig. 11, and the fillet radius and part of the aerofoil on the blade at the left have been completed on the machine just described.

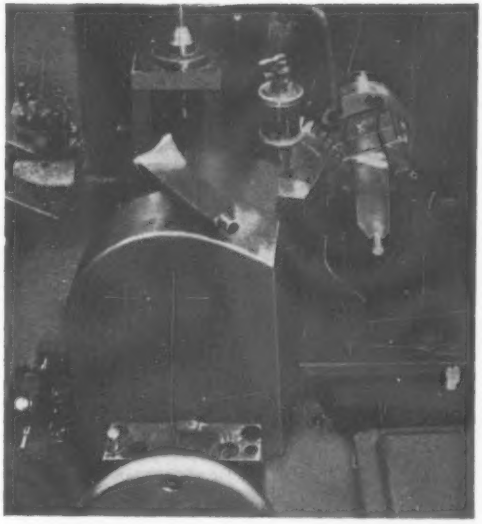

**Fig. 11. Close-up View from the Operator's Position, of the Work Holder and Cutter on the Machine in Fig. 10. The 5-in. Diameter Cutter has 40 Carbide-tipped Teeth and is Driven at 600 ft. per Min.**

Two different types of machine are employed for operations on aerofoils, and on both, provision is made for holding the blade by the finished root surfaces in clamping jaws, and supporting the outer end by means of a dead centre. A centre hole must therefore be drilled in the cylindrical pip at the end of the aerofoil and for this purpose, the company have built a simple machine, equipped with a small, automatic drill-head unit. After they have been centre-drilled, the blades are transferred to the section for operations on the aerofoil.

## OPERATIONS ON AEROFOIL SURFACES

As was mentioned earlier in this article, two methods are employed for finishing aerofoil forms, and with one of these methods the required shape is produced on each side, in turn, on abrasive-band machines of the type developed by J. L. Jameson, Ltd., of which a large number is installed. On this machine, a hardened die block, shaped to the curvature required on the blade surface, is employed, across which runs an abrasive band. The blade, held in a fixture, is pressed into contact with the band, which is thus forced to assume

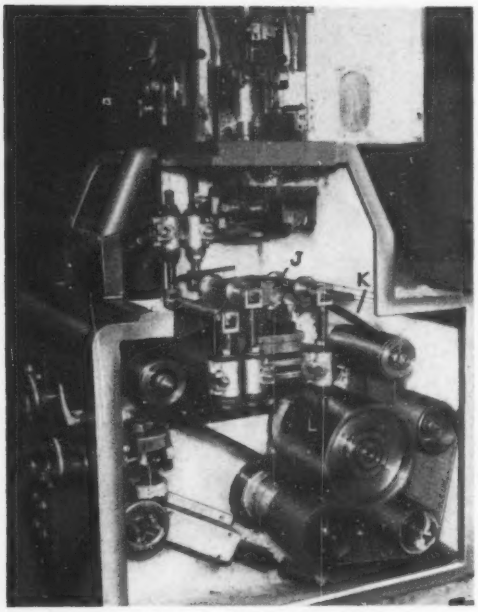


**Fig. 12. For Finishing the Aerofoil Surfaces of Blades a Large Number of Jameson Abrasive-band Type Machines is Installed. In this View, the Covers have been Swung Back to Show Internal Details**

the contours of the die as material is removed from the blade surfaces. The process is both rapid and accurate, and produces aerofoil surfaces which require only to be blended into each other at the leading and trailing edges, at a final finishing operation.

A general view of one of the Jameson machines, with the covers swung back to show the arrangement, is given in Fig. 12, where the hardened die is seen at *J*. As a rule, the dies are of mild steel, faced with some wear-resisting material such as Stellite. Above the contoured top surface of the die runs the endless abrasive band *K*, with the abrasive side upwards, and this band, which is 74 in. long and of a width to suit the blade that is to be finished, is driven by means of a drum *L*. The band is held in close contact with the drum by means of another band of woven material, which passes over three idler pulleys. Of 10-in. diameter, the drum is driven at a speed of 750 r.p.m., so that the surface speed of the abrasive band is of the order of 2,000 ft. per min.

At each side of the die-support table, there is an idler pulley for the abrasive band, and provision is also made for the fitting of one or two guide rollers immediately adjacent to the die on each side. These rollers are held in square-section bearing blocks at each end, the blocks being retained by screws in the slotted ends of vertical screwed bars. Each bar is supported in a bracket, those at the front being secured to a slotted surface on the side of the die-support table, and those at the rear to the table, and to a similar slotted surface on the machine casting, as convenient. These bars can be adjusted both vertically and horizontally to align the guide rollers with the entry and exit edges of the die to ensure that the abrasive belt hugs the die face as closely as possible. Since the drum *L* turns in a clock-wise direction, as viewed in Fig. 12, the entry side for the band is on the left-hand side of the die, and sprays of paraffin are applied to this side by means of a length of drilled pipe, to lubricate the band and cool the work.

The set-up here shown is for a blade of larger size than those so far discussed, with a fir tree root for mounting in a compressor rotor. A close-up view, showing the method of holding the blade, is given in Fig. 13, from which it may be seen that the root end is clamped against a lower fixed jaw, by means of a moving jaw, applied by turning the star wheel *M*. Before this wheel is tightened, the centre hole in the cylindrical pip at the other end of the aerofoil is engaged by a centre which is advanced by turning the other star wheel *N*. The blade holder is secured to the lower end of the ram of a vertical hydraulic cylinder, mounted in the machine casting above the position occupied by the die-support table, as seen in Fig. 12. Rate of oil flow to this cylinder, from a pump housed in the machine base, is governed by a flow control valve, so that any required speed of movement of the blade holder can be obtained.

At each side of the ram there are limit switches, and as the ram descends the switches are tripped by adjustable dogs. The limit switches control solenoid-operated hydraulic valves and serve to provide a fast approach and slow feed rate during the downward movement of the ram, also a fast return rate. With the band running, the blade is brought down until light contact is made, whereupon the slow rate is engaged, a typical feed being 0·001 in. during a period of 8 sec. As soon as the pre-set quantity of material has been removed from the blade surfaces, the direction of the oil supply to the cylinder is reversed, and the blade holder is withdrawn to the loading position shown.

For stainless steel blades, a typical band is of 60 grit, supplied by Thos. Goldsworthy & Sons, Ltd., but the size and type of abrasive varies considerably, depending on the blade material.

Two variations of the Jameson machine, which was originally designed for finishing operations on blades up to 4 or 5 in. long, are also employed in the works. On one of these machines, after finishing a portion of a long blade, the head can be moved horizontally to operate on the remainder, the entire length being finally finished during a traversing movement of the head as it returns to its original position. The other modified machine is so arranged that it may be fitted with a wider band, to allow long blades to be machined at a single stroke. Machines are installed in double lines in the shop, those which operate on different sides of the same blade being arranged in pairs, so that blades which have been finished on one side can be immediately loaded into the adjacent machine. Between each double line of machines, there is a row of O.M.T. optical projectors, on which the operators can check the aerofoil contours and the chordal width as the blades are finished.

A series of hand operations is next performed on the blades, including the blending of the root fillet radius into the aerofoil surfaces and the finishing of the leading and trailing edges. Emery bobs are employed to polish these surfaces and the blades may also be vapour blasted or barrel-finished according to customers' instructions. The location pip on the end of the aerofoil is removed, and the blade is cut to the required overall length on one of a battery of adapted surface grinders, as described in the previous article, and the blades then enter the inspection department for final checking.

Installed in this department, there are Sigma units on which as many as 40 dimensions can be checked simultaneously, also a variety of optical projectors and other equipment.

Further articles, which it is hoped will be published shortly in this series, will describe the use of Ex-Cell-O blade milling, grinding and polishing machines, also the manufacture of cams for these units. The production of turbine blades from Nimonic alloys, the broaching of the fir-tree roots, and the machining of aerofoil surfaces on hydraulically-operated copy-shaping machines, will also be considered.

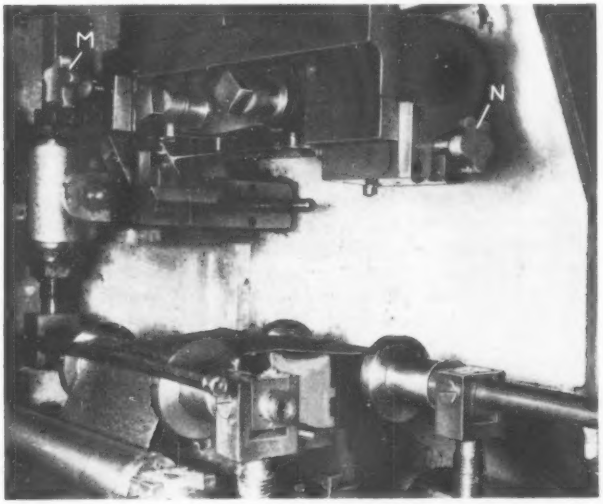


**Fig. 13. Here, Details of the Blade-holding Arrangement and the Roller Guides for the Abrasive Band on Each Side of the Stellite-faced Die can be Seen. A Band Speed of 2,000 ft. per min. is Employed for Stainless Steel**

## Heavy-duty Lifting Magnet for Stock Yards

Rapid Magnetic Machines, Ltd., Lombard Street, Birmingham 12, have introduced a powerful lifting magnet for handling material from haphazardly-stacked stockpiles. Hitherto, circular-pattern magnets have been used, but with this type the magnetic force is disposed principally at the centre pole, which is approximately one third of the diameter of the magnet.

The new "Rapid" TLM.55.48 magnet is of rectangular form, and a powerful field extends over the entire length of the operating face. In consequence, it is claimed that loads can be lifted which are substantially greater than those handled with a comparable circular type.

A TLM.55.48 magnet, 55 in. long by 48 in. wide, is being employed in the railway sidings of a large works in Manchester, to lift loose 2¼-in. square billets, with a total weight of 8 tons. As a result, the number of men required for handling operations has been reduced from five to two, and there has been a saving in handling time. Further to facilitate handling, motorized spreader beams can be incorporated, whereby the load may be turned through 90 deg.

# Chucking Arrangement for Hot-rolled Tubing

Where parts are machined from tubing on automatics, considerable savings can sometimes be made by using hot rolled material provided that the chucking arrangements are such that the diameter variations can be safely accommodated. To meet this requirement, investigations were carried out by The Timken Roller Bearing Co., U.S.A., in conjunction with the New Britain Machine Co., New Britain-Gridley Machine Division, and later with National Acme Co. and the Cone Automatic Machine Co., Inc. After various possible solutions to the problem of ensuring adequate chucking pressure over the necessary size variation range had been investigated, an arrangement incorporating Belleville springs as shown in Fig. 1 was adopted.

Referring to Fig. 2, which shows load deflection and stress deflection curves for a single Belleville spring, it will be observed that over a deflection range from 0·30 to 0·45 in. the load varies only from 11,000 to 11,600 lb. and the stress does not exceed a specified maximum of 170,000 lb. per sq. in. Where greater loads are required, two or more springs may be nested together, and where provision must be made for greater deflection, two or more springs may be reversed.

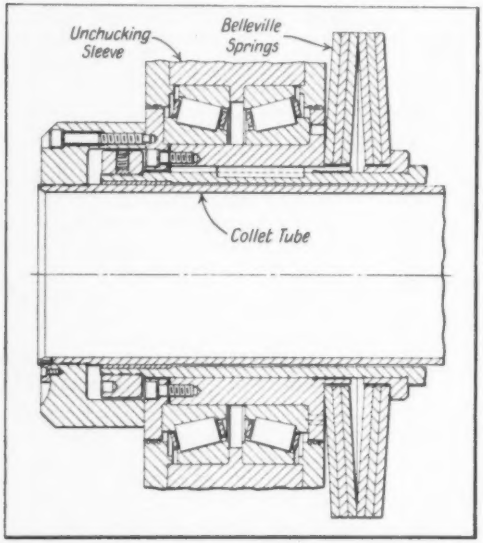


**Fig. 1. With this Arrangement, the Closing Force is Applied to a Collet Tube by Belleville Springs and Diameter Variations in Hot Rolled Tubes can thus be Accommodated**

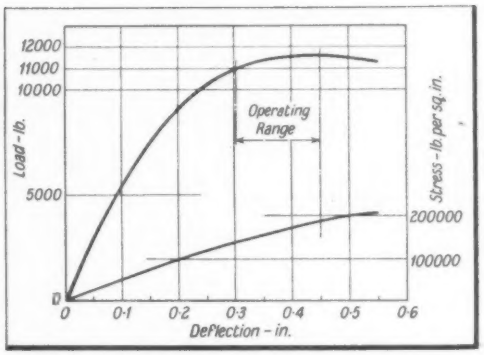


**Fig. 2. Typical Deflection/Load and Deflection/Stress Curves for a Single Belleville Spring**

With the arrangement illustrated in Fig. 1, the deflection of the springs is at the specified minimum when a tube of the smallest acceptable diameter is gripped in the collet and adequate holding pressure is then insured. At the same time, the permissible deflection provides for the largest acceptable tube, with an adequate margin for opening.

During the cutting cycle, the springs supply the load necessary for chucking. For stock feeding, an external load is applied to the collet opening sleeve so that the springs are compressed and the collet is thrust forward. Under normal operating conditions, pressure is applied by the springs through the sleeve carrying the bearing cones directly to the collet adjusting nut, so that no spring load is applied to the bearings.

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WIRING SMALL PARTS FOR ROTO-FINISHING OPERATIONS—Small components which require a Roto-Finishing operation at the works of Hawker Aircraft, Ltd., are threaded on to soft iron wire, which is then bent round and twisted to form a loop. The loops are 3 to 4 in. long, and it is stated that parts secured in batches in this manner do not adhere to the sides of the barrel during processing, and are more readily separated from the chips at the end of the operation.

# Hermetal Double Bond Filled Epoxide Resin

## *Its Properties, and Some Typical Applications*

Originally introduced in 1956, by the Kenilworth Manufacturing Co., Ltd., West Drayton, Middlesex, Hermetal Double Bond is a metallic synthetic material with numerous applications, which is said to be gaining increasing acceptance in various engineering fields. Available in putty, cream, and pouring grades, it comprises a combination of chemically-reactive epoxide-based resins, and mineral and aluminium powder fillers, which sets chemically to a hard, tough mass, with exceptional bonding properties. The three grades are provided as a matter of convenience to the user, and differ only in the type and amount of filler that each contains. In other respects, they are virtually identical.

The reactive mixture is prepared by blending together, in suitable proportions by volume, two separately-packed ingredients. No reaction takes place until the ingredients are mixed, and they can, therefore, be stored indefinitely. Rate of setting depends on temperature, and at 60 to 70 deg. F., full hardness is reached in 15 to 24 hours, the corresponding useful pot life being 2 to 3 hours. At 120 deg. F., the mixture is fully cured in approximately 1 hour, whereas at 180 deg. F., the curing time is reduced to 5 or 10 min. Provided that the ingredients are thoroughly mixed, hardening takes place uniformly throughout the whole mass.

Bonding properties are such that the material will adhere strongly to metal, most plastics, glass, wood, and rubber. It is harder than lead, and has machining properties generally similar to brass, so that it can readily be sawn, filed, drilled, and tapped, and may be sanded to a feather edge without risk of cracking or flaking. During sanding, it may be noted, the amount of fine airborne dust produced is slight, and it is claimed that at no time is the material toxic.

The putty is suitable for mixing and working with the fingers, for applications in which a fairly large bulk is required, such as filling-in and smoothing deep cavities. It can be worked to a smooth, accurately-contoured surface, requiring little final finishing, by the use of soap-solution. The latter serves as a lubricating medium, thereby allowing the surface to be "wiped" to shape with the fingers or a suitable tool. An important characteristic of the putty is that it can be used as a basic material, from which components, tools and moulds can be produced, as will be described later in this article.

More mobile, the semi-liquid cream is convenient for use when it is required to spread a relatively thin layer over a large area to provide a surfacing material, for example, although the putty can, in fact, be employed in a similar manner. In addition, the cream is suitable for filling seams, cracks and porosities, and is mixed and applied with a spatula. It has the same curing characteristics as the putty. The pouring grade, which is free-flowing when mixed, is intended as a casting medium and it may be noted, in all other respects, is similar to the cream. Since it has a lower filler content, however, it has better wetting properties, with correspondingly improved adhesion.

In all three grades, one ingredient is of a metallic grey colour, due to the aluminium powder filler, and the other is off-white. For the majority of applications, these ingredients are used in equal proportions, and mixing is continued until the mass is of a uniform grey. This metallic appearance is retained when the material has set. When prepared in the proportions mentioned, and cured at 176 deg. F., the material has a tensile strength of 3,860 to 4,300 lb. per sq. in., with an elongation of 5 per cent. The compressive strength is 7,500 to 8,950 lb. per sq. in., and the modulus of elasticity 2·8 to $3{\cdot}3 \times 10^4$. For bonding tests between aluminium or mild steel plates, a typical shear value is 1,000 lb. per sq. in., and notch tests show an impact strength of 0·2 to 0·5 ft.-lb. per in. notch. The density is 14·9 cu. in. per lb. for the putty, and 18·2 cu. in. per lb. for the cream.

Dimensionally stable, the material is unaffected by hydrocarbon oils, petroleum products, greases, alcohols, weak mineral acids and alkalis, and organic solvents. Any type of paint, including cellulose and stoved finishes can be applied, and the material will also adhere strongly to any paint film.

When preparing surfaces for the application of Double Bond, it is only necessary to ensure that they are clean and free from grease, and for this purpose, any of the usual solvents, such as trichlorethylene, is suitable. Although not essential, an etch primer gives improved adhesion to non-ferrous metals.

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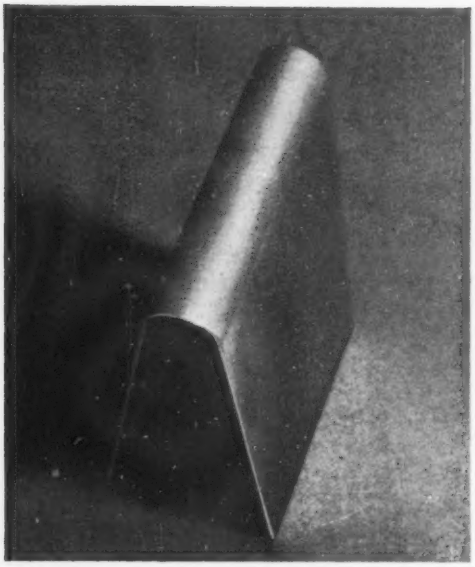

**Fig. 1. Hermetal Double Bond Bend-test Specimen, Showing Strength of Bond to Aluminium Alloy, and Flexibility. The Sheet was Bent through 160 deg. on an ½-in. Mandrel**

An indication of the strength of the bond to aluminium alloy, and the flexibility of the material, is afforded by the bend-test specimen shown in Fig. 1. The test-piece comprised a strip of 18 s.w.g. L.72 Alclad material, in which was machined a shallow recess, 1 in. wide and 0·02 in. deep. This recess was filled slightly above the level of the surrounding surface, with a mixture of equal proportions of the cream-grade ingredients, which was left to harden for 24 hours at room temperatue. When hard, the material was scurfed smooth and level, and the strip was bent through an angle of 160 deg., on a ½-in. diameter mandrel. As may be observed in Fig. 1, there was no evidence of cracking, or failure of the bond. Similar results are obtained with the putty. Even greater flexibility can be obtained by changing the proportions of part *A* to part *B*, to a maximum of 2:1.

The flexibility, freedom from shrinkage, and tenacity of Double Bond render it particularly suitable as a substitute for lead in repairing damage to motor-vehicle bodies, and it is, in fact, extensively employed for this purpose by the General Post Office, in maintaining some 16,000 of its fleet of 37,000 vehicles. Originally, the toxicity of lead constituted a major problem, but this difficulty has now been overcome by the use of Double Bond. Considerable interest in this particular use of the material is also being shown in the motor industry, where lead is extensively employed in preparing car-body pressings for finishing.

Apart from its non-toxicity, an advantage of Double Bond as a substitute for lead in this application—and, indeed, as a substitute for solder in many other instances—is the ease with which it can be applied to vertical and inverted surfaces, and in situations where the use of a soldering iron would be difficult or dangerous. In the aircraft industry, the material is being adopted increasingly

**Fig. 2. Typical Applications of Double Bond, Illustrating its Versatility, and General Properties**

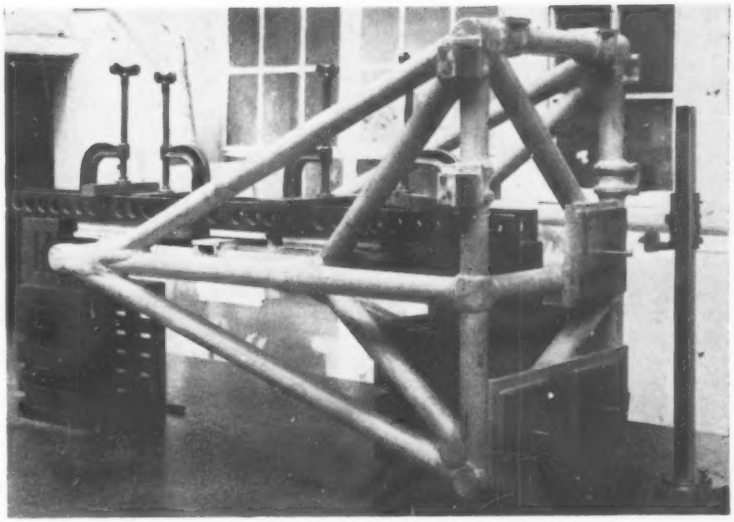

**Fig. 3. Aircraft Fixture Constructed from Epifil Resinated Glass Fabric Tube, with Double Bond as a Jointing Medium**

as a filler for smoothing joints, and rivet and bolt indentations, on aerodynamic surfaces; as a means of forming accurate seatings for pilot's cockpit transparency assemblies; and for the construction of various types of tooling.

The versatility of Double Bond is well illustrated by the specimens shown in Fig. 2. At the upper left is seen an elbow, with an average wall-thickness of ⅛ in., and with limbs of 1½ in. and 1⅜ in. external diameter. This example was produced entirely from the putty, by using the following technique. A simple pattern was prepared from stiff carboard tube by mitring and gluing, and the putty was spread over it to the thickness indicated, smoothed, and allowed to harden. The cardboard was removed by soaking in water until soft, when it was readily stripped from the bore of the work. Very little final finishing was required, other than lightly dressing the ends of the limbs.

A generally-similar method was employed for preparing the bars of material for the machining-test specimens at *A* and *B*. For each of these examples, a roll of the putty was inserted in a carboard tube, and pressed in so that it filled the bore. The hardened plug was subsequently removed by soaking and stripping the cardboard. Both specimens demonstrate the ease and cleanness with which the material can be machined. The piece at *A* was grooved and profiled, and tapped at one end ½ in. diameter by 16 threads per in., the threads being clean and well formed. Similar characteristics are shown by the test piece at *B*, which is approximately 1½ in. diameter and 7 in. long. It has variously-profiled turned and end-milled grooves, and an external square-threaded portion with a pitch of 6 t.p.i.

The specimen seen immediately above that at *B* serves to illustrate the manner in which Double Bond can be employed for jointing, sealing, and fabricating various components, structures, and vessels, in polyester/glass-fibre materials. The particular example illustrated comprises a length of Nu-glas resinated glass fabric tube (Ogden Smiths & Hussey, Ltd.) secured to a flat pad of plastics material with a fillet of Double Bond putty. This method of construction is gaining popularity in the aircraft industry for jigs and fixtures, on the grounds of economy, ease and rapidity of fabrication, and rigidity combined with exceptional lightness. The latter characteristics are especially important where portability is concerned, for instance, in reference-fixtures for checking major dimensions and components for interchangeability.

A typical fixture of this type, constructed for the De Havilland Aircraft Co., Ltd., by Bourdon Tools, Ltd., Croydon, Surrey, is shown in Fig. 3. As may be observed, it incorporates a number of flat datum-pads, which are mounted on flat "plates" of plastics material secured to the main structure by fillets of Double Bond, either directly, or by means of webs. In a fixture of conventional welded construction, the plates would necessarily be equally massive, and correspondingly heavy. Moreover, the pads would normally be mounted and aligned on the plates with the aid of low melting-point alloy, which, again, is relatively heavy.

Fabricated from Nu-glas tube, the fixture in Fig. 3 is extremely light, yet has a rigidity comparable with that of a tubular steel structure. No special skill is required in applying the Double Bond putty to form the joints, and since this material is dimensionally stable, and no heat is

involved, problems analogous to welding distortion do not arise. For the same reasons, the various members can readily be held in position, by simple arrangements, while the joints are hardening. The datum-pads, also, are secured to the support-plates with Double Bond, and are accurately aligned and set in this manner. In Fig. 3, it may be noted, two of the main datum-pads are seen temporarily aligned, for this purpose, with a pair of straight-edges, which are clamped against them.

Referring again to Fig. 2, at the bottom left and right are seen two specimens that serve to illustrate the great adhesion of Double Bond, between both metallic and non-metallic surfaces. On the left is a pair of white vitreous-enamelled steel plates, which were cemented together with a special grade of Double Bond cream, containing mineral filler only. The plates were 3 in. wide, and were overlapped 1¾ in. When the cream was cured, the plates were broken apart. As may be observed, a large area of glaze was stripped from one plate, and remained attached to the other.

The second example comprised a stainless-steel plate, 2 in. wide and 6 in. long, polished on one side of the longitudinal centre-line, and scurfed on the other. A strip of Formica of the same length, and 1¾ in. wide, was attached on each side of the centre-line with standard-grade Double Bond cream, so that approximately ⅜ in. projected beyond the edges of the stainless-steel. After curing, the specimen was tested by applying manual pressure to these projecting portions, and with both types of surface, fracture occurred only in the Formica, with no evidence of failure of the bond. The dark areas seen in Fig. 2, it should be noted, are the surface of the stainless steel, outside the roughly elliptical area to which the adhesive was applied.

An indication of the manner in which Double Bond putty can be employed as a moulding material is afforded by the fuse-box components seen at the upper right in Fig. 2, and shown in greater detail in Fig. 4. Approximately 4½ in. long and 4 in. wide, the base has an average wall-thickness of ¼ in., and incorporates an appreciable amount of detail. The only machining required was the drilling and counterboring of the holes, and end-milling the pocket *C*. The cover, which also has an average wall-thickness of ¼ in., has an internal stiffening rib of the same thickness, by ⅜ in. deep. Both these components were produced from inexpensive wooden patterns and plaster moulds, in the course of a prototype development programme, for which only small quantities were required. The cost of the patterns and moulds was only a few shillings.

In applications of this type, it is, of course, necessary to employ a parting medium, to prevent the material from bonding to the mould. For this purpose, a product known as D.B. Relag is recommended by the manufacturers, although most of the agents in common use, such as Traffic Wax, are satisfactory. It is important, however, if silicone products are employed, to ensure that they are not allowed to come into contact with the ingredients while the latter are being mixed.

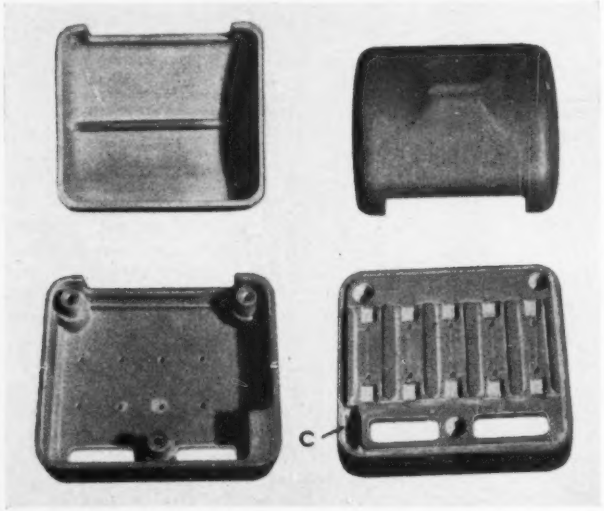


**Fig. 4. The Prototype Fuse-box Components Here Shown were Produced in Double Bond Putty, from Inexpensive Wood Patterns and Plaster Moulds**

Another interesting example of the use of Double Bond putty in bulk, is afforded by the trunnion-mounted, nest-type fixture shown in Fig. 5, which is employed for drilling aircraft components. The uprights and the polygonal support-frame are of conventional welded tubular steel construction, but the bowl-shaped nest portion, which incorporates steel drill-bushes and inserts, is entirely of Double Bond, and is 40 in. diameter. Steel clamping elements were bonded to the bowl with the cream, and this material was also used for attaching the bowl to pads on the support-frame.

For producing the bowl, the following procedure was employed. The

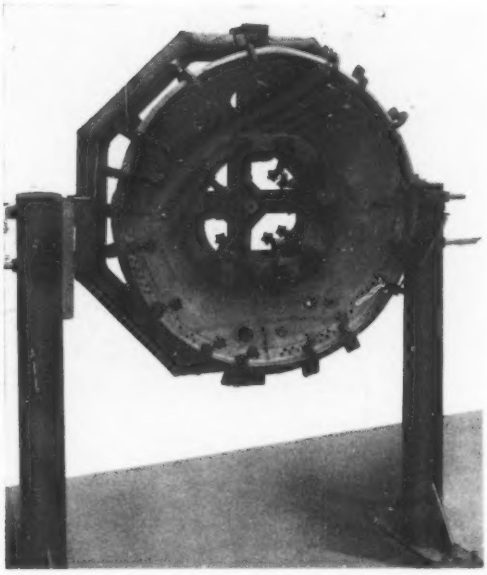

**Fig. 5. The Bowl Portion of this Nest-type Aircraft Drilling Fixture was Constructed from Double Bond Putty, and Incorporates Steel Drill-bushes and Inserts**

components in question are aluminium-alloy sheet spinnings, and the first spinning was carefully marked-out and drilled, to produce a standard part, which was then used as a master. Drill-bushes and inserts were first degreased, and secured in position by bolts passing through the drilled holes, and the surface of the spinning was coated with Relag. Particular care was taken at this stage, to ensure that the parting medium was not unintentionally applied to the bushes and inserts also. In Fig. 5, it will be observed that there is a number of larger holes near the periphery. These holes, which are of ⅜ in. diameter, are not bushed, and provide for access to the work with a riveting gun. They were formed by attaching additional bushes to the spinning, which served as cores, and were coated with Relag so that they could readily be ejected from the finished moulding.

When the bushes and inserts had been assembled, and the Relag applied, the spinning was coated with Double Bond putty, by spreading layer upon layer until the required thickness had been built up. Although not essential, a layer of wire netting was incorporated to provide reinforcement, as a precautionary measure. Once the material had set, the drill-bushes and inserts were unbolted from the spinning, and the latter removed, leaving the bushes and inserts securely bonded in position in the moulding. Very little final cleaning-up was required.

The fixture has proved satisfactory in service, and the time required for its construction was considerably less than that for alternative conventional tools. Since the Double Bond bowl is rigid and self-supporting, the rear is free from additional structure, and unobstructed access is afforded for drilling. Because the fixture is relatively light, it is readily rotated on the trunnions, and locked with a pull-out pin.

Apart from the applications mentioned, Double Bond may be employed on a wide variety of repair work; for soft jaws and other special work-holding devices; for foundry and other patterns—for example, for use as masters on tracer-controlled machine-tools; for sealing porous castings; for filling corrosion pitting in storage tanks and vats, and providing corrosion-resisting linings in similar vessels; for pointing masonry where resistance to chemical attack is required; and for bedding heavy-duty glass.

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MORGANITE WHEEL FLANGE LUBRICATING ROD—For application to the wheel flanges of rolling stock and travelling cranes, The Morgan Crucible Co., Ltd., Battersea Church Road, London, S.W.11, have introduced the Morganite flange lubricating rod, of soft graphite material enlased in a harder carbon tube. The lubricant is applied only to the wheel flanges, to which it adheres strongly, and as it is a "solid" there is no risk of it creeping or running on to the tread. A simple holder can be employed for the rod which is held constantly in contact with the flange.

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HELLERMANN DUMMY FUSES—Many electrical installations and switchboards are designed in such a manner that extra wiring can be connected at a future date, and in these instances there are often unoccupied fuse sockets. The vacant sockets may be a potential danger, since new fuses may be inserted, or, alternatively, old fuses replaced, in them, by error. To avoid this risk, Hellermann, Ltd., Crawley, Sussex, have developed a range of dummy fuses, which are made in four sizes, equivalent to 2-, 2·5- to 5-, 10-, and 40-amp. capacity. These dummies, which are made of polystyrene plastics, are coloured red, are marked with the words "not in use," and have coarse serrations on the body portion so that they may be identified by touch.

# Producing Striking Levers on a Conomatic with an Eccentric-milling Attachment

In MACHINERY, 92/188-24/1/58, reference was made to the set-up on a 3½-in., 6-spindle, British-built Conomatic machine for producing a striking lever shaft coupling, which involved the application, at the fifth spindle position, of a special slot-milling attachment. This machine, which was built by the Cone Automatic Machine Co., Ltd., Aldridge, Staffs, is installed at the works of Vauxhall Motors, Ltd., Luton, Beds, and the latter company are using a similar machine for producing the striking lever, seen in the accompanying line-drawing Fig. 1.

Originally, this component was made from a forging, but it was found that by using special-section En. 8a bar, as shown at *X* in Fig. 1, substantial savings could be achieved as regards machining time and material cost. With the new method, the 1·195, 1·595, and 1·657-in. radii, seen struck from a centre which is ⅞ in. off-set from the 0·512-in. diameter hole, are machined with the aid of an eccentric milling attachment at the fourth spindle position.

Referring to the sectional side-view in Fig. 1, it will be seen that the workpiece has a cranked form, and at the first spindle position a forming tool, mounted on the cross-slide, is employed to break down the material towards the 0·323/0·327-in. radius. At the same time, a tool in a second holder, mounted against, and adjustable relative to, the form-tool holder, takes a front facing cut, and a 1¼-in. diameter, 90-deg. point, drill, in the main slide, is advanced to perform a centring operation. Also mounted on the main slide at this spindle position, is a knee-turning tool, which serves to produce a 0·080-in. wide by 60 deg. chamfer on the front edge of the workpiece.

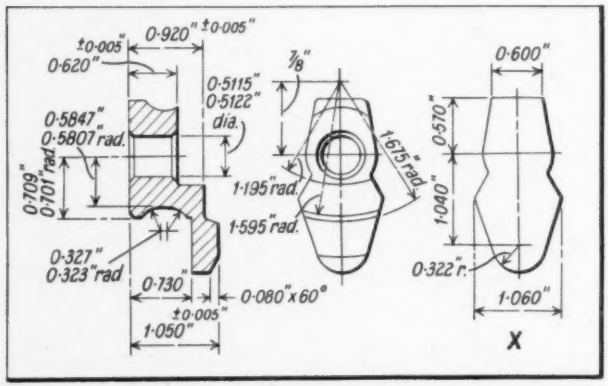


**Fig. 1. Striking Lever which is Produced in a Cycle Time of 50 Sec., on a British-built, 3½-in., 6-spindle Conomatic Bar Machine. The Form of the Special-section En. 8A Bar Material, is Shown at *X***

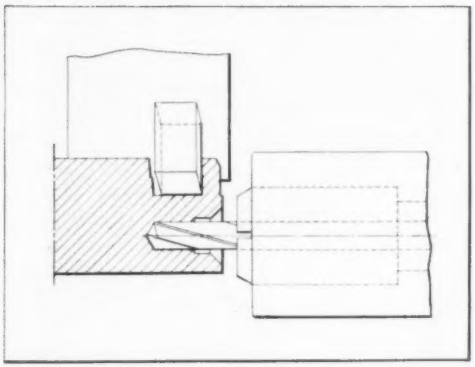

**Fig. 2. Tools at the Third Spindle Position Serve to Finish-form the Back Face of the Flange, and Drill the Centre Hole in Preparation for a Subsequent Reaming Operation**

At the second spindle position, the breaking-down and front-facing operations, just mentioned, are continued by tools carried on the cross-slide, and a ⅝-in. diameter drill with a 90-deg. point, mounted in the main slide, is fed in to a depth which is just sufficient to form the chamfer at the outer end of the 0·512-in. diameter hole.

The tooling employed at the third spindle position is shown in Fig. 2. At this stage, the back face is finished by a tool carried on the cross-slide, and a 12·8-mm. (0·504-in.) diameter drill on the main slide is applied to bring the central hole to the required size for a subsequent reaming operation. Here, also, can be seen the

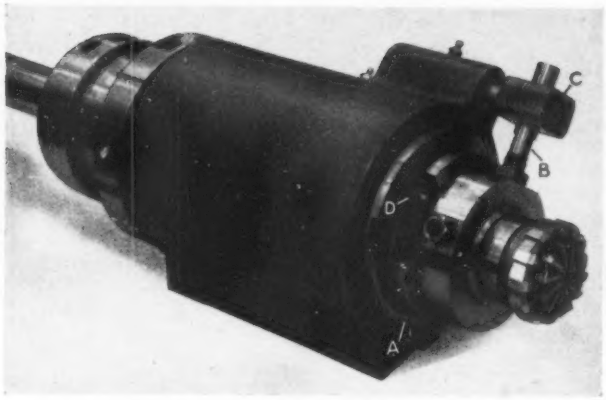


**Fig. 3. The Special Eccentric-milling Attachment which is Used at the Fourth Spindle Position to Machine the Three Off-set Radii on the Striking Lever**

centre which is formed by the 1¼-in. diameter drill at the first position, and the depth to which the ⅝-in. diameter drill is fed at the second position.

As already mentioned, an eccentric milling operation is carried out at the fourth spindle position, and a close-up view of the attachment for this purpose is given in Fig. 3. The eccentric sleeve *A* is carried within a cast-iron, housing mounted on the main slide, and is driven, by means of the shaft seen extending at the left, from the right-hand column of the machine (when viewed from the front). A timing adjustment is provided so that the drive to the eccentric sleeve can be synchronized with that of the work spindle, and the importance of this feature will be explained later. A milling quill and spindle are contained within the eccentric sleeve, both of which are prevented from rotating about their axes by the swivelling guide rod *B*. This rod is screwed into a tapped hole provided in the quill, and the upper end slides in a hole in the swivelling anchor block *C*. A cylindrical extension on this block is accommodated in a bored hole in a lug on the main housing, where it is restrained from moving axially but is free to turn about its axis. The small gear *D*, which is keyed to a square-ended shaft, permits of setting the amount of eccentric throw required. The two side and face milling cutters seen mounted on the spindle in Fig. 3, are of suitable form and diameter to produce the 1·195, 1·595, and 1·675-in. radii, seen on the end view of the workpiece in Fig. 1.

Bearing in mind the fact that the milling spindle, and therefore the cutters, do not rotate about their own axes, reference should now be made to Fig. 4, which illustrates the relative motions and positions of the workpiece and the cutters during the milling operation. The centre of the 0·512-in. diameter hole in the workpiece, is, of course, coincident with the centre of the machine spindle, and the eccentric sleeve in the milling attachment has been adjusted so that the cutters are off-set by ⅞ in. from that centre. This position is shown clearly at *A* in Fig. 4, where the swivelling anchor pin, and a number of the teeth on the larger cutter, can also be seen.

At *B*, the workpiece has been rotated through 90 deg., and the drive to the eccentric sleeve,

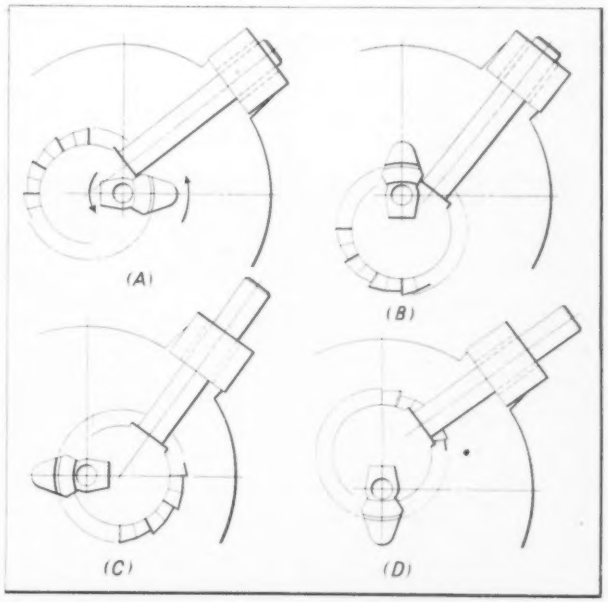


**Fig. 4. Diagram Showing the Relative Positions of the Workpiece and the Eccentrically-Mounted Milling Cutters at 90-deg. Intervals During One Complete Revolution**

which is synchronized with that of the spindle, has moved the centre of the cutters through a similar angle, thereby maintaining the original relationship. However, since the radii of the cutters is greater than the amount of the off-set, a relative motion has taken place between the teeth of the cutters and the work, and it is this motion which provides for the milling action. At *C* and *D* in Fig. 4 are indicated the relationship of the work and the cutters at the two succeeding, 90 deg., positions, and the extent to which the anchor pin is displaced angularly and longitudinally.

The line drawing, Fig. 5, shows the eccentric milling attachment in position at fourth spindle station, also the tool carried on the cross-slide which is used to start the parting-off operation.

Finish-forming of the 0·327/0·323-in. radius is continued, at the fifth spindle position, as shown in Fig. 6, by means of a tool on the cross-slide, and the facing operation is completed by a tool mounted on the same slide. In addition, a recessing tool on the main slide is applied to machine a V-shaped groove in the bore, one flank of which forms the chamfer at the inner end of the 0·512-in. diameter hole, when the workpiece is parted off.

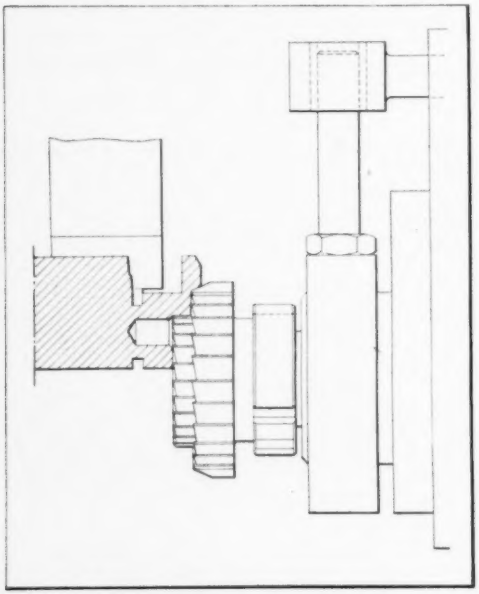

**Fig. 5. The Tooling at the Fourth Spindle Position at which an Eccentrically-mounted Milling Spindle, Driven in Synchronization with the Machine Spindle, is Employed. The Cutters do not Rotate About their Axes, the Milling Action being Obtained by Relative Motion Between the Teeth and the Work**

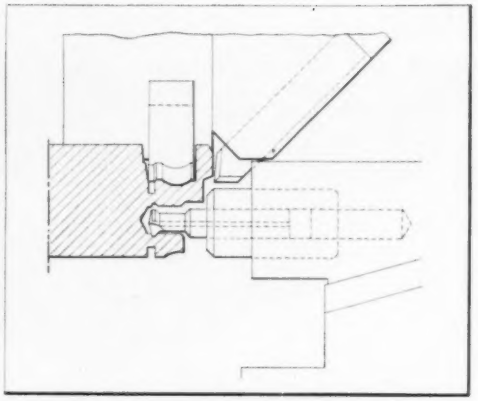

**Fig. 6. The Tooling at the Fifth Spindle Position, at which the Forming and Facing Operations are Completed, After the Work has been Parted Off at the Sixth Spindle Position, the Right-hand Flank of the V-shaped Annulus forms the Chamfer at the Left-hand End of the Hole**

At the sixth spindle position, the hole is finished to size by a David Brown reamer, with a No. 2 Morse taper shank, carried in the main slide, and, finally, the workpiece is parted-off by a tool carried on the cross-slide. The spindle speed employed is 187 r.p.m., and the cycle time is 50 sec.

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MICROHONING HOLES IN TITANIUM ROTOR DISC SPACERS. In a recent issue of *Cross Hatch*, published by Micromatic Hone Corporation, Detroit 38, Michigan, U.S.A., reference is made to equipment supplied by the company to Pratt & Whitney Aircraft, Division of United Aircraft Corporation, for finishing holes in titanium spacer rings of channel section. Material thickness ranges from 0·075 to 0·11 in., and there are 16 equally-spaced holes through both flanges of each ring. The holes are of either 0·59 or 0·68 in. diameter, and the pitch circles for different rings range from 24·5 to 36 in. Provision is made for automatic indexing of the work and the 16 holes in a ring are finished by automatic microhoning in a cycle time of about 7 min. An average of 0·004 in. of stock is removed from each hole, and a tolerance of 0·0005 in. is maintained for size and roundness, with a surface finish of 15 micro-inches.

The set-up can be changed for a different size of ring in a few minutes.

# Special-purpose Machines at the Skoda Motor Car Factory

The name of Skoda, Czechoslovakia, has been well-known for many years in connection with the manufacture of motor vehicles, the passenger cars being made at Mlada-Boleslav, not far from Prague. The works here were originally established by Laurin & Klement, who were pioneers in the industry more than 50 years ago.

Under the planned economy in Czechoslovakia, industrial factories are being gradually modernized, and while at Mlada-Boleslav much still remains to be accomplished, a certain amount of special-purpose equipment, designed to meet present-day production requirements, is now installed, the majority of which has been developed and built in Czechoslovakia. In this article, reference is made to some of the more interesting examples.

The main product is the Skoda 440 car, seen in the heading illustration, which is fitted with a 4-cylinder, overhead valve, water-cooled engine of 1,089 c.c. capacity, developing 40 h.p. at 4,200 r.p.m. Features of the engine include an aluminium cylinder block fitted with wet liners of

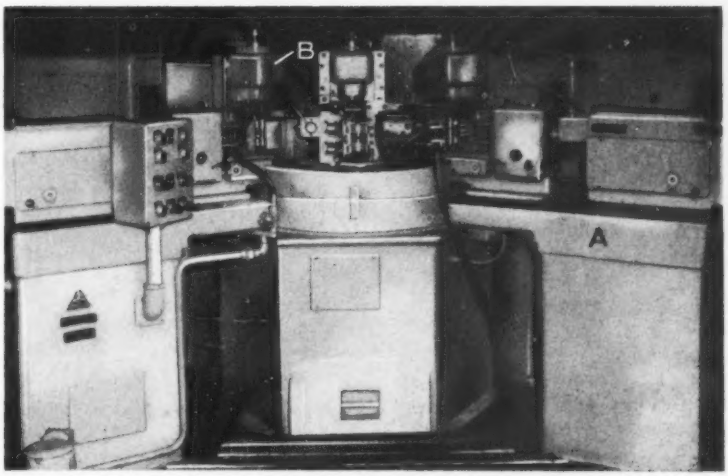



**Fig. 1. Special-purpose Unit Head Machine for Performing Drilling, Milling and Reaming Operations on Steel Half Bearing Shells**

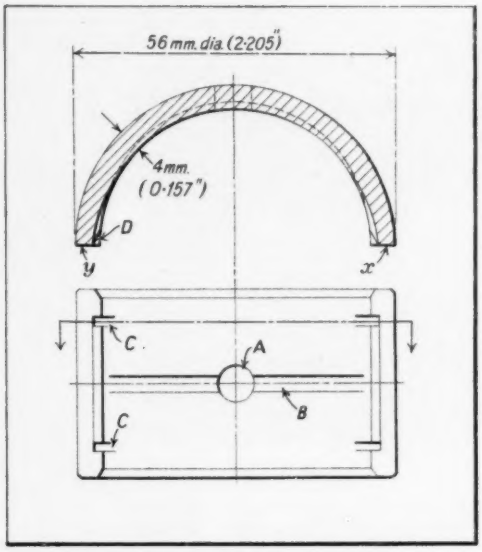



**Fig. 2. Details of the Half Bearing Shell Handled on the Machine Seen in Fig. 2.**

heat-treated cast iron. The chassis incorporates a centre tube and a forked front member which carries the engine and gearbox, and independent suspension is provided for both the front and rear wheels. This car is also available as the Skoda 445, with an engine of slightly larger capacity, and as the 450 sports version, fitted with a twin-carburetter, high compression engine. In addition, there is the Skoda 1201 saloon which is powered by the 45-h.p. engine, and station wagons, delivery vans, and ambulances are also being built.

Total production capacity at Mlada-Boleslav is about 150 cars per day at the present time, and two—in some sections of the factory, three—shifts are being worked on a 46-hour week basis. Basic wage rates are paid for a minimum specified output per shift, and there is a bonus for additional output.

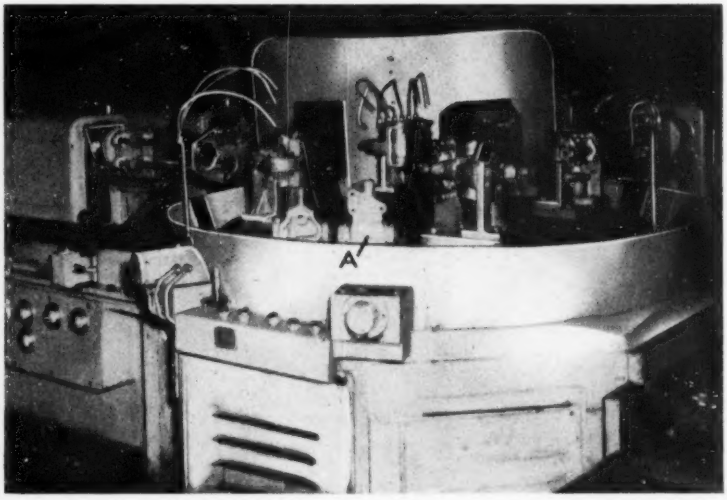



**Fig. 3. Horizontal Unit Head Machine for Drilling, Reaming and Tapping a Cast Aluminium Component**

### SPECIAL-PURPOSE UNIT HEAD MACHINES

A number of unit-head machines built by the Czechoslavak machine tool works TOS-Kurim are installed, and an example is shown in Fig. 1. The component in question is a steel, half-shell bearing, some details of which are given in Fig. 2, and the operations performed comprise: drilling the centre hole *A*; milling the centre groove *B*; milling the two grooves *C* at each side; milling the bevels *D*, and, finally, reaming the centre hole. Two components are handled at a time, mounted one above the other in the fixture. Location is taken from the face *x* of the shell, and hydraulic clamps are applied, under the control of a single lever, to the faces *y* of the two workpieces. The latter are held endwise against support faces in the fixture by means of upper and lower leaf springs.

The 6-station fixture table is indexed hydraulically, and all the unit heads are of the quill type, with lead-screw feed. Slide bases, as at *A*, are provided to support the spindle heads, and the milling operations are carried out by means of cutters mounted on vertical spindles, as seen at *B*.

Fig. 3 shows a horizontal machine equipped with a hydraulically-indexed, 4-station table and four unit heads of the screw-feed type mounted on slide bases, for drilling seven holes, reaming

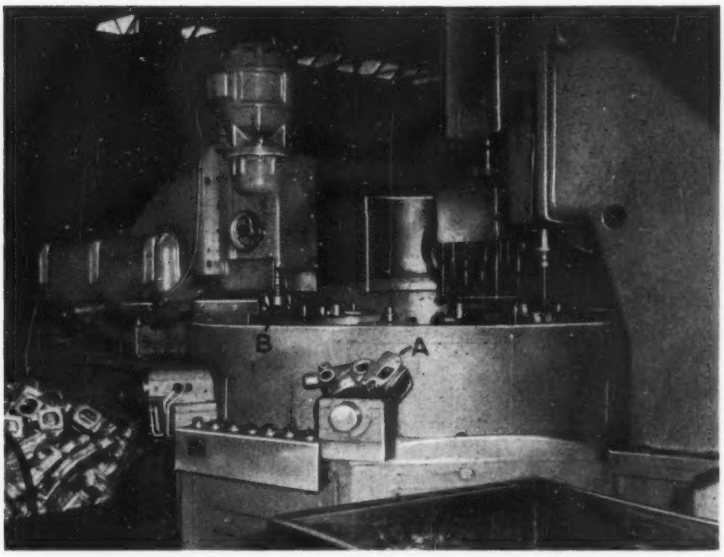



**Fig. 4. Special-purpose Machine for Carrying Out Milling, Drilling and Facing Operations on a Cast Aluminium Water Pump Housing**

three holes, and tapping four holes under lead screw control, in the light-alloy casting seen at *A*. In this instance, the workpiece is clamped by hand in the fixture. Reference may also be made to the machine shown in Fig. 4, for carrying out milling, drilling, and spot-facing operations on the cast aluminium water pump housing *A*. Indexing of the 4-station table, and work clamping, are effected hydraulically, and the cycle time for the machine is 1·4 min. The table indexes in a clockwise direction and the milling operation is carried out with an inserted-blade tungsten-carbide cutter, *B*, on a vertically-adjustable spindle head, which is carried on the main horizontal traversing head.

An example of a unit-head machine which is fitted with a drum-type, hydraulically-indexed fixture is shown in Fig. 5, the component being a cast-aluminium gearbox cover. There are three working stations and a loading and unloading station on the drum, and the fixture clamps are applied by hand. Multiple drilling operations are performed by a vertical head and a left-hand horizontal head, which are mechanically operated, and by a hydraulically - operated right-hand head, the cycle time being 1·9 min. A machine of similar construction is installed for drilling certain other holes in this component, also for performing tapping operations. In addition, mention may be made of a horizontal, double-ended, drum-type machine, which is arranged for hydraulic indexing and fixture clamping. This machine is employed for rough- and finish-turning, chamfering, and facing operations on the arms of forged-steel universal-

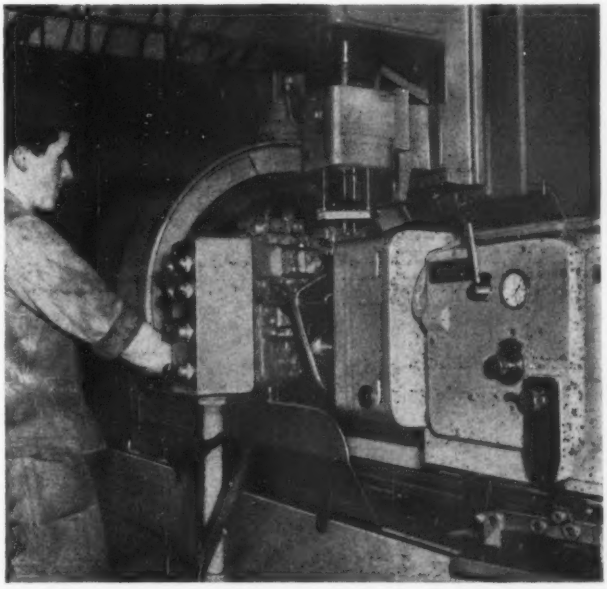


**Fig. 5. Drum-type Unit Head Machine for Multiple Drilling Operations on a Gearbox Cover**

joint spiders, and each unit head carries 10 spindles.

At the time of our visit, only one in-line transfer machine, shown in Fig. 6, was installed. This machine has been in use for several years, and is designed for carrying out drilling, reaming, and facing operations on the valve guide holes of cast iron cylinder heads. No fixtures are employed, the work being indexed hydraulically from one station to the next along rails, and clamped from above. There are six working stations and the operations are performed by three unit heads, of the lead-screw feed type, arranged at alternate transfer positions, at each side. The exhaust ducting for removing the fine cast iron dust will be noted. It is understood that in-line transfer machines are to be built for machining the light alloy cylinder block and gearbox castings.

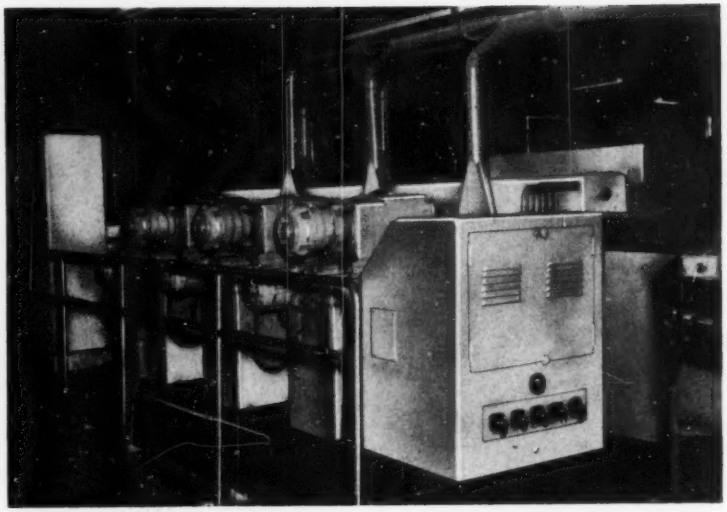


**Fig. 6. In-Line, 6-station, Transfer Machine for Drilling, Reaming, and Facing Valve Guide Holes in Cast-iron Cylinder Heads**

Other equipment recently installed in the machine shop includes the Czech-built hydraulic camshaft grinder seen in Fig. 7, also two 6-spindle chucking automatics and two 6-spindle vertical chucking machines supplied from Russia. Machines of German origin include, for example, Klingelnberg bevel gear generators, and a Schenck dynamic balancing machine for propeller shafts.

Bodies for the Skoda 440 and 445 cars are made at Mlada-Boleslav, and in this connection an extensive new press shop, now partly in operation, has been built which will provide improved work-handling facilities, as compared with the smaller existing shop. Mechanical presses up to 1,000 tons capacity are in use, most of which were supplied some years ago by Pels, Schuler and Weingarten, and there is a number of new, Czech-built presses up to 500 tons

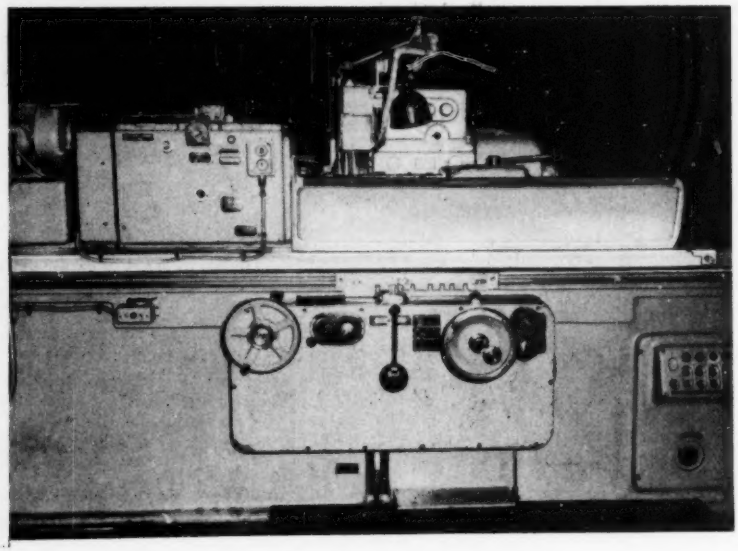


**Fig. 7. Czech-built Hydraulic Camshaft Grinder Installed at the Skoda Works**

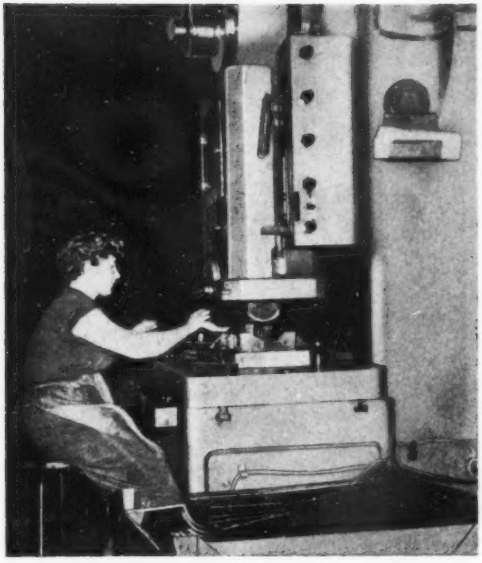


**Fig. 8. A Czech-built End-wheel Press of 160 tons Capacity, in Operation at the Skoda Works**

capacity. The application of photo-electric guards on a Pels 1,000-ton press may be noted. Certain operations are performed on Schuler and HPM hydraulic presses which have been installed for some time.

One of the Czech-built presses—an end-wheel type of 160 tons capacity—is seen in Fig. 8, set up for forming dash-board glove box covers. The stroke of this press is adjustable from ⅞ to 4¾ in. and a ram adjustment of 4 in. is provided by worm and worm wheel. A positive knock-out is incorporated in the ram and provision is made in the 40- by 28-in. table for fitting a pneumatic drawing cushion. Drive to the press is taken from a 15-h.p. motor through V-belts and an air-operated multi-plate clutch and brake unit, controlled either by push-buttons or a movable pedal switch. The press can be set for continuous running, single-stroke operation controlled by one or both hands, or single-stroke operation controlled by the pedal. The multi-plate clutch also permits the ram to be inched for tool setting. An overload protection device is incorporated in the ram, and the working parts of the press are lubricated by a centralized pressure system.

A forging plant is being established adjacent to the new press shop, which will produce components for Skoda cars previously obtained from other factories in Czechoslovakia. Czech-built crank forging presses, which are now available in capacities up to 4,000 tons, are being installed, and Fig. 9 shows a type LKM press, of 2,500 tons capacity, being set up on its foundations.

The frame of this press is a one-piece steel casting, and the 55- by 47-in. table has ⅝ in. of vertical adjustment, by screw and wedge, for die setting. The ram, which has a stroke of 13¾ in., moves in long, adjustable guides, and is pneumatically balanced. Drive to the eccentric shaft is taken from a motor of 150 h.p. through V-belts, reduction gears and an air-operated, multi-plate clutch, the speed of operation being 50 strokes per min. A band brake on the left-hand end of the eccentric shaft is automatically applied when the

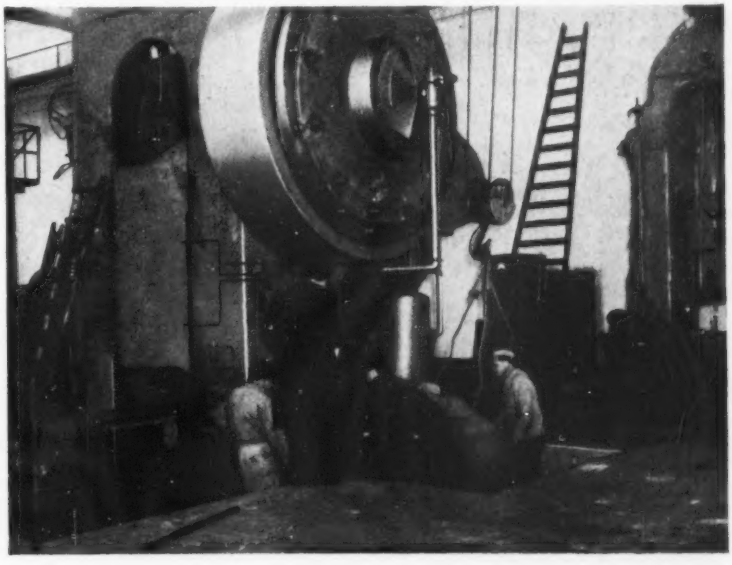


**Fig. 9. Installing a Czech-built Mechanical Forging Press, of 2,500 tons Capacity, in the New Forging Department**

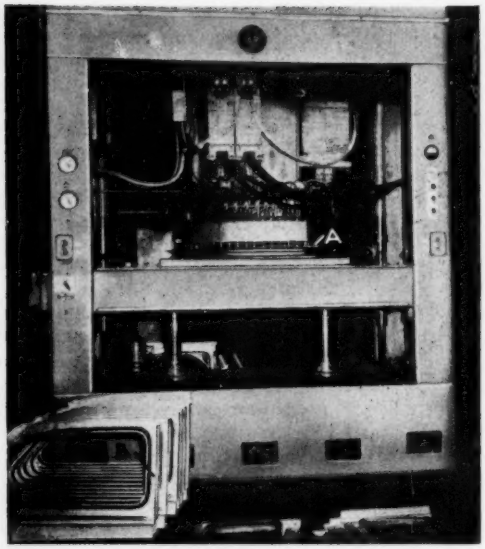


**Fig. 10. Multiple Automatic Spot Welder, of Czech Construction, for a Rear Window Frame**

clutch is disengaged, and a compressed-air operated shoe brake is provided to stop the flywheel when the main motor is switched off. The electro-pneumatic controls may be hand- or foot-operated, and a change-over switch enables them to be set for single-stroke or continuous running, also for inching. A safety device, which is adjusted hydraulically, is incorporated in the flywheel to obviate damage from overload. Top and bottom ejectors are provided, the bottom ejector being operated by a cam on the eccentric shaft, through a system of levers and pull rods. A centralized lubrication system is incorporated. This press weighs approximately 190 tons.

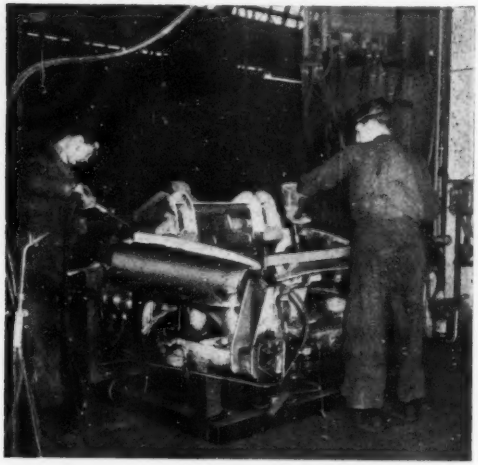


**Fig. 11. One of the Floor-mounted Welding Jigs, of Skoda Design, Installed in the Body Shop**

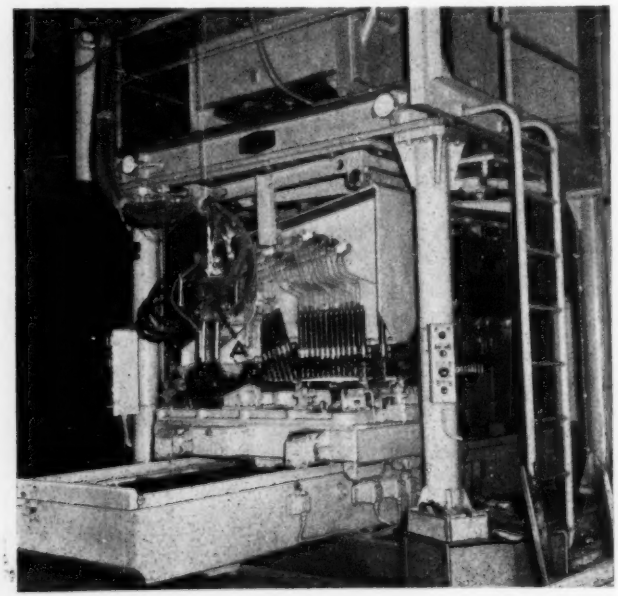


**Fig. 12. Automatic Spot Welding Machine, Supplied by the Belgian Firm Electromecanique, for Producing a Floor Plate Assembly**

Production methods in the body shop conform, in general, to up-to-date practice, and Czech-built equipment recently provided includes the automatic multiple spot welder shown in Fig. 10, which is designed to spot weld together, at 36 points, two pressed components forming a rear window frame assembly. The table, carrying the work fixture and lower electrodes, is raised and lowered by two hydraulic rams, and in the illustration it is seen raised, with the work *A* gripped between the electrodes.

Finished assemblies are indicated at *B*. The machine is attended by a girl operator, and the cycle time is 30 sec.

Automatic multiple spot welders, incorporating the latest features, have also been supplied by the Belgian firm Electromecanique, one of which, for welding together the two components of a floor assembly, is shown in Fig. 12. The table of this machine is arranged to traverse along bedways, and it is seen in position beneath the main electrodes. Pressings are loaded on to the table when the latter is fully withdrawn to the left, clear of the electrodes, and certain tack-welding operations are first performed, using the overhead portable gun *A*. The cycle start button is then depressed, whereupon the table automatically indexes to the right, through several positions, the welding operation being carried out in stages.

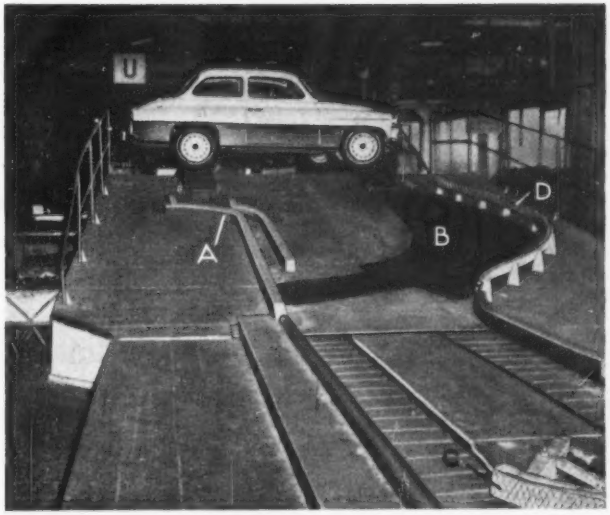



**Fig. 13. View at the Delivery End of the Main Assembly Line for Cars at the Skoda Works**

Fig. 11 shows one of a number of floor-mounted welding jigs, designed and built by Skoda, for handling other parts of the body assembly. In this jig, the wings and front part of the body are located and welded, the various components being held by air-operated clamps. The main assembly operations on the body are carried out on the installation shown in Fig. 14, which incorporates six welding jigs mounted on an annular table. The latter rotates continuously at slow speed, and welding is performed with portable guns suspended from trolleys running along overhead circular tracks. An output of eight bodies per hour is obtained from this welding line.

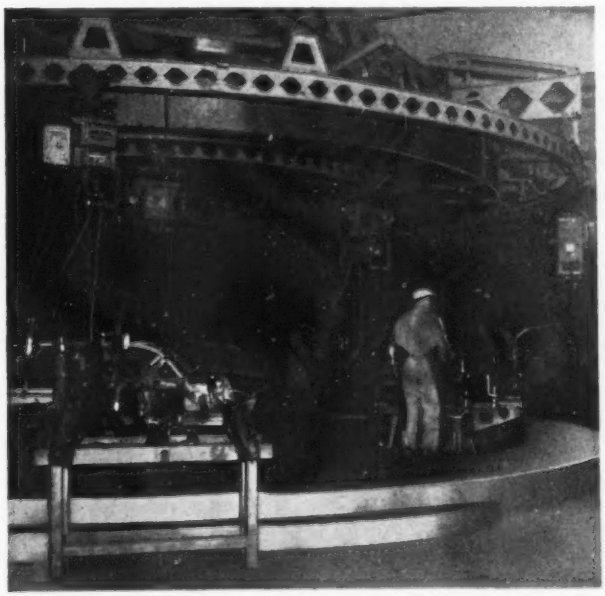


**Fig. 14. Turntable Installation with Six Welding Jigs, for the Main Assembly of the Body**

The completed bodies are dip-coated with a phosphate anti-rust preparation, and then with primer, in a conveyorized plant of Skoda design, installed about a year ago. In this plant, the bodies are carried in cradles suspended from a conveyor chain, which is indexed step by step. The cradle is lowered automatically into the dipping tanks, and then rotated by power, to ensure complete coverage. In connection with finishing, it may be noted that the chassis, engine, rear axle, and front suspension assembly are spray painted and then

oven dried as a unit, on a conveyorized installation, as is common in the manufacture of tractors.

A view of part of the main assembly line is given in Fig. 13. The various stages of assembly are carried out with the cars arranged transversely on the conveyor, as may be seen, and at the end of this section of the line they are turned through 90 deg. as they move down an inclined ramp, in preparation for running off the power-driven conveyor in the foreground. The assembly conveyor extends for several feet down the ramp, and the left-hand run terminates in a curved guide channel *A*, which acts as a stop for the leading rear wheel. As the front wheels move off the right-hand conveyor they pass on to curved roller tracks *B*, and thus, under the action of gravity, the car swings round. When the in-line position is approached, the rear wheels move out of the curved into the straight part of the left-hand guide track, and the car then runs forward on to the conveyor in the foreground, where it is arrested by the application of a shoe brake *C*. A safety fence, incorporating rollers, is provided at *D*, to guide the front wheels as the car swings round.

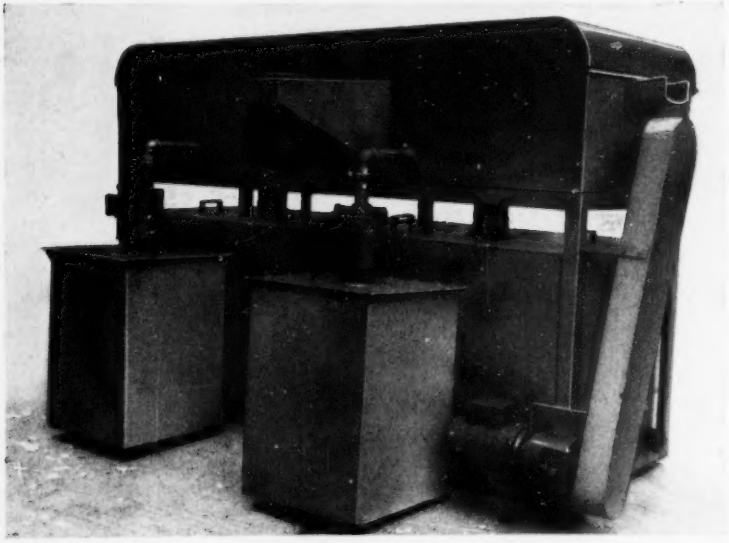
## De Laval Rotary-drum Washing Plant

Shown in the illustration is the De Laval rotary-drum washing plant recently introduced by Alfa-Laval Co., Ltd., Great West Road, Brentford, Middlesex, for cleaning machined and pressed metal parts and die castings, for example.

The parts to be cleaned are loaded by hand, or by a vibratory feed unit, into an inclined chute at one end of the unit, then pass by gravity into a perforated metal drum which is continuously rotated by a motor drive. A pipe, which is sealed at the centre, extends for the length of the drum, and cleaning solvent or hot detergent solution is delivered to the portion at the loading end by a motor-driven pump. The cleaning solution is finally directed on to the workpieces through holes in the wall of the pipe. A helical rib attached to the inside surface of the drum causes the parts to be continuously moved axially and turned over so that all surfaces are presented to the fluid.

If required, rinsing fluid may be delivered to the other end of the pipe by a separate motor-driven pump, and thence directed on to the work through nozzles. Electric, steam or gas equipment can be provided for heating the fluids, also for drying cleaned components which are discharged from the unit by way of a second inclined chute. Separate tanks with detachable strainers are incorporated in the base for the cleaning and rinsing fluids, and a fume extraction system can be employed.

Since washing and rinsing is carried out on a continuous basis, workpieces can be handled at high rates. When components contaminated with cutting oils are to be cleaned, the equipment may be used in conjunction with a De Laval centrifugal oil purifier, which is arranged to separate the oil from the washing fluid. It is stated that as much as 30 gal. of cutting fluid may then be reclaimed per day. The washing equipment is available in two sizes with drums of 24 in. diameter by 10 ft. long, and 12 in. diameter by 6 ft. long.



**De Laval Rotary-drum Washing Plant**

# The Design and Application of the Wego Patent Optical Tool Goniometer

By CHARLES MINAIRE*

Although it is of relatively simple construction, the Wego patent optical tool goniometer can be employed for measuring a wide range of angles on cutting tools of different types. For example, it can be applied to the measurement of the rake- and clearance-angles of milling cutter teeth, including cutters of the shell type, or those with straight or tapered shanks; the point- and clearance-angles of twist drills; and the cutting angles of reamers, taps, form-milling cutters, circular and rectangular form tools, broaches, and screwing dies. Since the arms that support the microscope are about 12½ in. long, the instrument can be used for measurements on tools of considerable size. Moreover, since measurements are made with the aid of a microscope (of 10× magnification), the instrument also enables the condition of the cutting edge to be examined, and the quality of finish, on the ground surfaces that form the cutting edge, to be checked.

## CONSTRUCTION OF THE INSTRUMENT

A general view of the Wego goniometer is given in Fig. 1. The support member *A* is mounted on a vertical pivot on the large-diameter base *B*, and can be swung through 360 deg. to suit the convenience of the operator and to provide the brightest image in the microscope eyepiece. Once set it can be locked in position. The microscope *C* incorporates a fixed graticule with a circular scale, concentric with the optical axis, and an adjustable graticule with two lines at 90 deg., which intersect on the optical axis. The circular scale is divided into 10-deg. intervals, which are subdivided by 5-, 1- and 0·5-deg. graduations, the apparent distance between successive 0·5-deg. graduation lines being 0·03 in. The graticule with the cross-lines can be rotated relative to the graduated graticule by the knurled sleeve *D*.

The microscope *C* is fixed to a carriage which can be moved on the arm *E* by turning the serrated knob *F*. This knob is connected to a pinion that engages with rack teeth cut on the arm. The arm itself is mounted on a second carriage, which can be moved along the arm *G* by a similar rack and pinion arrangement. By moving the microscope on the arm *E*, the intersection point of the lines on the adjustable graticule can be set in coincidence with the apex of the angle that is to be measured, and by adjusting the arm and microscope assembly on the arm *G*, the optimum setting, for magnification and sharpness of focus, can be obtained, in relation to the face of the workpiece that is being examined.

Workpieces are mounted on the support *H*. Cylindrical tools, such as end milling cutters and reamers, with plain or tapered shanks, are mounted

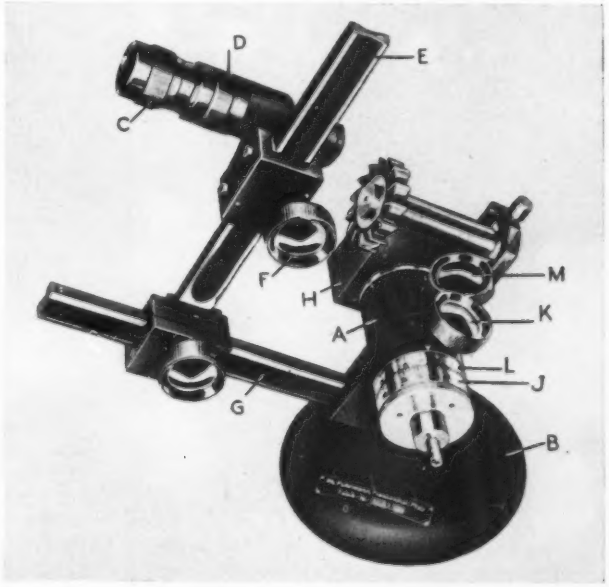



**Fig. 1. A General View of the Wego Patent Optical Tool Goniometer, Showing the Construction and Various Adjustments**

* Chief of Metrology, National Arms Factory, St. Etienne, France.

directly in a V-groove which is machined and ground in one long side of the support. Disc-type milling cutters, and other tools that normally are mounted on an arbor, are fitted to a mandrel, which, in turn, is supported in the V-groove, as may be seen in Fig. 1. Lathe (and other non-rotating) tools are mounted on the flat face of the support *H*, opposite to the V-groove (lowermost in Fig. 1). This face is parallel to the axis of the V-groove in one plane, and the tools are set with reference to the side face of the support (which is parallel to the axis of the V-groove in a plane at 90 deg. to the first plane), and with the end face of the support (which is a right-angles to the axis of the V-groove).

Two holes are bored through the support *H* parallel with the side face and in alignment with the axis of the V-groove. Sliding freely in each hole is a cylindrical permanent magnet, which can be locked in position by means of a socket-head screw. These magnets are used to hold the tool-supporting mandrels, in the V-groove, or on the opposite location face.

The support *H* is secured to a shaft which passes through the member *A*, and can be tilted in a plane that is paralled with the plane of movement of the microscope. The angle of inclination of the support *H* in relation to the optical axis of the microscope can be read directly from the calibrated drum *J*. The support *H* can be locked in any angular position by means of the serrated-head screw *K*, and when the zero mark on the drum coincides with a datum mark, the V-groove of the support is parallel with optical axis of the microscope.

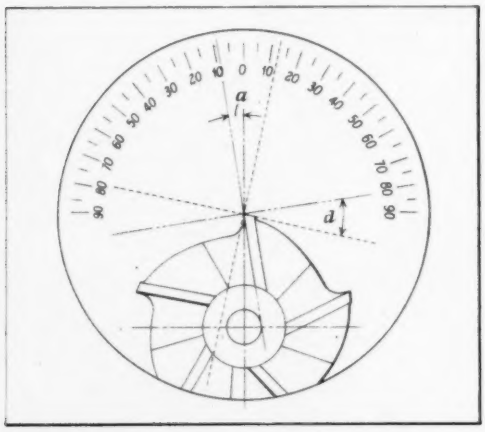



**Fig. 2. A Representation of the Image in the Microscope when the Rake and Clearance Angles of an End Milling Cutter are Being Measured. The Finer Calibrations on the Circular Scale have been Omitted for Clarity**

In addition to its angular movement, the support *H* can be displaced through a distance of $\frac{3}{16}$ in., in a direction at 90 deg. to the microscope axis, by a micrometer adjustment. The amount of displacement can be read from the drum *L*, which is graduated in units of 0·01 (0·00039 in.), and, at the zero setting, the axis of the V-groove of the support is located in the plane of movement of the microscope.

The complete assembly of the microscope and its supporting arms, and the pivot for the support block, can be swung about a horizontal pivot in the member *A*, in order that the microscope and work can be set in the most convenient position. Once set, the assembly can be locked in position by means of the knob *M*.

## METHOD OF APPLICATION

In general, the angle between two faces of a tool is measured by mounting the tool on the support *H*, and adjusting the microscope until the centres of the fixed and moving graticules coincides with the apex of the angle that is to be measured. Then, one of the lines on the movable graticule is aligned with one angular face of the tool, and the value where the line cuts the scale on the fixed graticule is noted. Next, the line on the moving graticule is aligned with the other angular face, and a second reading is taken. From the values thus obtained, the angle between the two faces of the tool can readily be derived. It will be apparent that the tool can often be set so that the first reading is zero, and the angle is then given directly by the second reading.

### (*a*) *Measuring the Rake and Clearance Angles of an End Milling Cutter.*

The cutter is mounted in the V-grooves of the support *H*, Fig. 1, and the support is located parallel with the microscope axis, by setting the calibrated drums *J* and *L* to zero. The microscope assembly is adjusted along the arm *G* until the image of the cutter is at the optimum brightness and sharpness. Next, the cutter is rotated and the microscope is raised or lowered, by turning the knob *F*, until the apex of the angle formed by the rake-face and clearance face of a tooth to be checked coincides with the centre of the graticules. By means of the sleeve *D*, the movable graticule is turned until one line coincides with the clearance face of the tooth, as indicated by dotted lines in Fig. 2, and the graticule is then

re-set to bring the other line into coincidence with the rake face of the tooth, as indicated by double chain-dotted lines. At each setting, the position of the lines is noted relative to the scale on the fixed graticule, and from these readings, the values of the rake angle $a$ and the clearance angle $d$ can be determined. In this instance, the angles are 9 and 12 deg., respectively.

The above procedure applies to an end milling cutter with a cylindrical shank. If the tool is of conical form or has a tapered shank, the support $H$ must be inclined, and the following procedures must be adopted.

*(b) Measuring the Angles of Conical Tools with Plain Shanks.*

A set-up for a tool of conical form with a plain shank is shown diagrammatically in Fig. 3. The support $H$ is inclined at an angle $q$, which is half the included angle of the cutter. Thus, the end of the tooth to be measured is presented normally to the microscope. The cutter, it may be noted, is held in the V-grooves by means of the permanent magnets $N$, as already mentioned. Using the method outlined in (*a*) above, the rake and clearance angles of the cutter are measured in a plane normal to the flank-generator of the cone. The values of the angles obtained, however, can readily be converted to values in the cutting plane, which is normal to the cutter axis. If the measured values for the rake and clearance angles are 9 and 12 deg., respectively, and $a$ is the true cutting rake and $d$ the true cutting clearance, the values of $a$ and $d$ can be found from the expressions $\tan a = \tan 9, \cos q$, and $\tan d = \tan 12/\cos q$.

*(c) Measuring the Angles of Cylindrical Cutters with Tapered Shanks.*

A set-up for checking a tool of cylindrical form with a tapered shank is shown diagrammatically in Fig. 4. The tool is mounted in the V-groove of the support $H$, but due to the tapered form of the shank, the axis of the cutter will not be parallel with the axis of the groove. Since it is necessary to present the end-face of the cylindrical portion normal to the microscope, the support must be inclined at an angle of $C$ deg. If $m$ deg. is half the included angle of the shank taper, sin $C$ is equal to 1·4142 sin $m$. For example, if a tool with a No. 2 Morse taper shank is being checked, the angle $m$ is 1 deg. 25 min. 50 sec., and the angle $C$ is 2 deg. approximately.

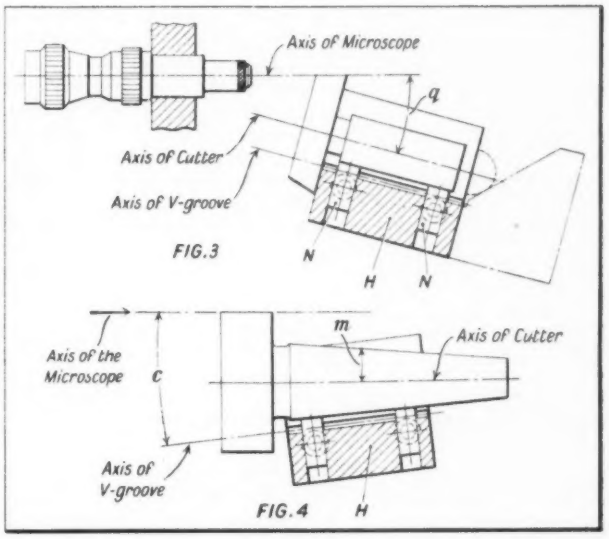



**Fig. 3. Diagrammatic View of the Set-up for Checking a Milling Cutter of Conical Form with a Plain Shank. Fig. 4. The Set-up for Checking a Milling Cutter of Cylindrical Form with a Tapered Shank is Here Shown Diagrammatically**

When large numbers of tools with tapered shanks are to be inspected, a sleeve may be employed with a corresponding internal taper, and cylindrical exterior. Then, the checking procedure is the same as that described in (*a*) above.

*(d) Measuring the Angles of a Cutter of Conical Form with a Tapered Shank*

(1) The set-up shown in Fig. 5 is used for measuring the cutting angles of the teeth of a cutter of conical form with a tapered shank, when the apex of the teeth and the apex of the shank lie on opposite sides of the end face of the cutter —as, for example, on a countersinking cutter. With the shank of the cutter held in the V-groove, the support $H$ is inclined at an angle of $C$ deg. relative to the axis of the microscope. The value $C$ is equal to $q - b$, where $q$ is half the included angle of the conical cutting portion, and $b$ is 1·4142 sin $m$, $m$ being half the included angle of the tapered shank.

(2) The set-up shown in Fig. 6 is employed when the apex of the teeth and the apex of the shank lie on the same side of the end face of cutter—as, for example, on a dovetail milling

cutter. Then, the angle $C$ is equal to $q$ plus $b$. For both (1) and (2), the rake and clearance angles measured directly by means of the microscope can readily be converted, as outlined in (*b*) above, to obtain the corresponding angles in a plane at right-angles to the cutter axis.

(*e*) *Measuring the Lip Angles of a Twist Drill*

When it is required to measure the lip angles of a twist drill, the tool is mounted in the V-groove

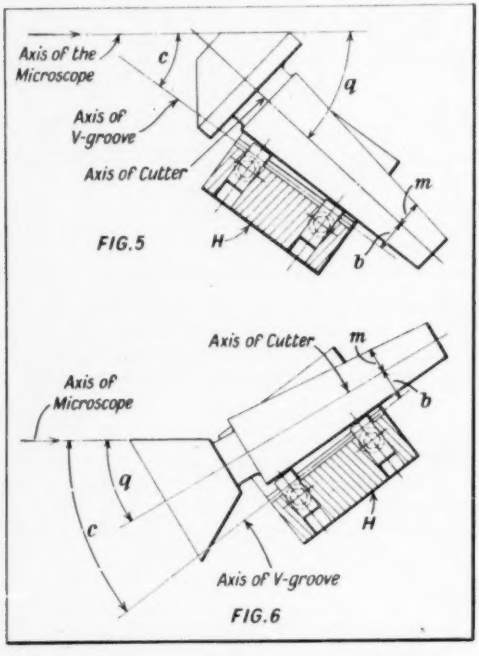



**Fig. 5. Diagrammatic View of the Set-up for Checking a Countersinking Cutter with a Taper Shank. Fig. 6. Diagrammatic View of the Set-up for Checking a Dovetail Milling Cutter with a Taper Shank**

of the support $H$, Fig. 1, and the drums $L$ and $J$ are set at 0 and 90 deg. respectively. The axes of the drill and the microscope are then set at 90 deg. to each other, but are located in the same plane. By adjusting the microscope assembly along the arm $G$, the image of the drill is brought to the optimum sharpness.

By means of the knob $F$, Fig. 1, the microscope is adjusted vertically, and, at the same time, the adjustable graticule is rotated by turning the knurled sleeve $D$, Fig. 1, to bring one of the cross-lines on this graticule into coincidence with the image of one of the the lips of the drill, as indicated on the left-hand side in Fig. 7. It will be observed that the axis of the drill-image coincides with the vertical axis of the fixed graticule, and the angle between the drill-axis and the lip that is being checked can be read directly, by noting the position where the line on the adjustable graticule cuts the scale on the fixed graticule. In this instance, the angle is 60 deg.

When one lip-angle has been checked, the adjustable graticule is rotated to bring the same cross-line into coincidence with, or parallel to, the other lip of the drill-image, as indicated by the chain-dotted line in Fig. 7. Again the position of the cross-line in relation to the scale is noted. In this example, both lips of the drill are at the same angle relative to the drill axis (that is, 60 deg.), but they are not symmetrically disposed in relation to that axis. The displacement of the drill point can be measured by moving the support $H$, Fig. 1, sideways, until the point-image coincides with the centre of the graticules, and then noting the setting of the micrometer drum $L$.

In addition to the application described, the goniometer can be used to check the helix angles and rake angles of drills, also the thickness of the webs. If drills with taper shanks are to be checked, a sleeve with a tapered bore and a cylindrical exterior can be employed, with advantage, for locating the tool, as already described in connection with the checking of milling cutters.

(*f*) *Determining the Setting Height of a Circular Form Tool*

The goniometer can be used to determine the setting height of a circular form tool, as indicated diagrammatically in Fig. 8. In order to obtain the correct rake angle, it is necessary to set the tool on the machine so that the cutting edge is at a certain vertical distance below the centre of the tool. This distance $T$ is a function of the radius $CX$ of the tool and the distance S measured normally from the top rake face of the tool to the centre.

To determine the distance S for a tool of given radius $CX$, the tool is mounted on an arbor or peg, which is secured in the V-groove of the support $H$, Fig. 1. The two measuring drums $J$ and $L$, Fig. 1, are set at zero, so that the axis of the tool and the axis of the microscope are parallel and in the same plane. One of the cross-lines of the adjustable graticule is then set in the vertical position by aligning it with zero on the scale of the fixed graticule.

The tool is rotated on its mounting until the top rake face $CB$ is parallel to the vertical cross-line. The support $H$, Fig. 1, is then displaced sideways until the face $CB$ and the cross-line coincide. The displacement of the support, which is equal to the value $S$, is read directly from the drum $L$.

From the value $S$, can be calculated the angle $B\hat{C}X$, since sin $B\hat{C}X$ is equal to $S/CX$. The angle $d$ (the top rake of the tool) is known, and $B\hat{C}X - d = D\hat{C}X = C\hat{X}A$. Then, the distance $T$ can be determined from the expression $T = CX.$ sin $C\hat{X}A$.

*(g) Measuring the Clearance Angle of a Tooth of a Screwing Die*

The rake angle of a tooth of a screwing die can be measured with the aid of the Wego goniometer, as indicated diagrammatically in Fig. 9. The rake angle $d$ is formed by the radius $CX$ (joining the centre $X$ and the cutting edge $C$) and the tangent to the periphery of the hole $D$, at the point where it is intersected by the radius $YC$.

To measure the angle $d$, the die is mounted in the V-groove of the support $H$, Fig. 1, and the graduated drums $J$ and $L$ are set at zero. The adjustable graticule of the microscope is set so that one of the cross-lines is vertical. Then, the die is rotated and the knurled knob $F$, Fig. 1, is adjusted to bring the centre of the graticules into coincidence with the cutting edge ($C$, Fig. 9) of one die tooth. Next, the adjustable graticule is rotated, to re-set the cross-line which was originally vertical, so that it is tangential to the front face of the tooth (that is with the periphery of the hole $D$) at the point $C$. This re-setting operation is of some delicacy, but it is possible to adjust the graticule with sufficient accuracy if the other cross-line (which originally was horizontal) is set to pass through the point $C$ and the centre $Y$ of the hole. The operation is facilitated, moreover, if a pin of a suitable diameter, and with punch mark in the centre of its end face, is located in the hole. The angle $d$ is read directly from the scale of the fixed graticule.

K. S. Paul, Ltd., Park Royal Road, London, N.W. 10, are the agents in this country for the Wego optical tool goniometer.

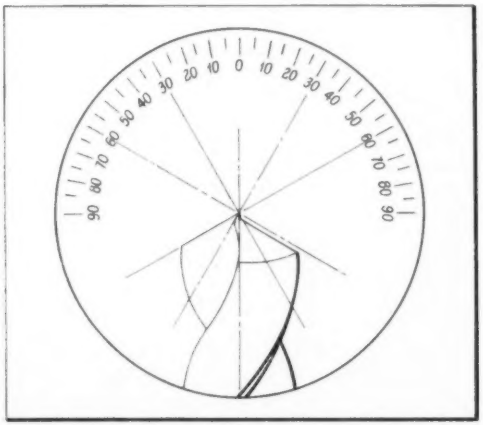


**Fig. 7. Representation of the Image in the Microscope when the Lip Angle of a Twist Drill is being Checked**

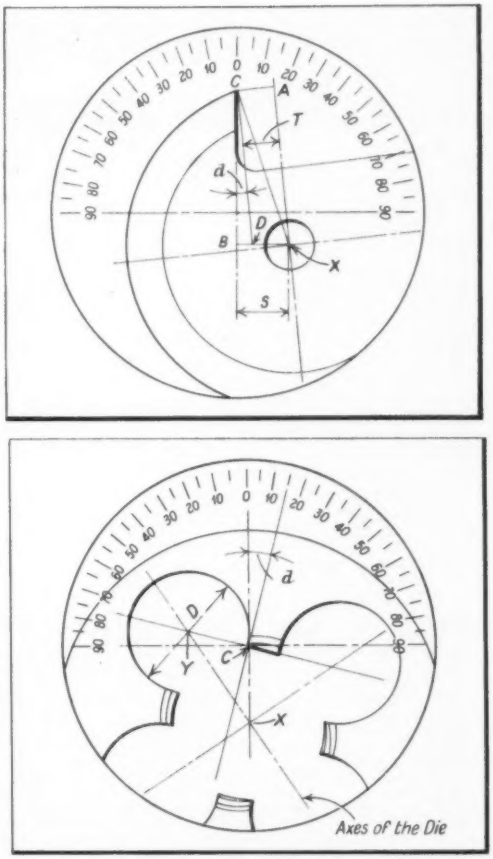



**Fig. 8 (above). Representation of the Image in the Microscope when the Setting Height of a Circular Form Tool is Measured. Fig. 9 (below). Representation of the Image in the Microscope when the Rake Angle of a Screwing Die is being Checked**

# Portable Column Unit for Use with Large Craven Boring and Turning Mills

Reference has already been made in MACHINERY, (91/804—4/10/57) to a 26-ft. 6-in. convertible-type, double-column, vertical boring and turning mill which was designed and built by Craven Brothers (Manchester), Ltd., Reddish, Stockport. Whilst primarily intended for use as a fixed-column machine, the design is such that the entire upper structure, comprising the two columns, the cross-slide complete with saddles, and the top tie-beam, can be removed *en bloc*, so that operations on workpieces beyond the normal capacity can be carried out with the aid of a self-contained portable column unit. At the time when the previous article was prepared, photographs of this portable column were not available, but since that date the company have designed and built another boring and turning mill (of 36-ft. capacity) solely for use with a portable-type column, and the fixed columns and cross-rail, normally associated with this type of machine, have been omitted entirely.

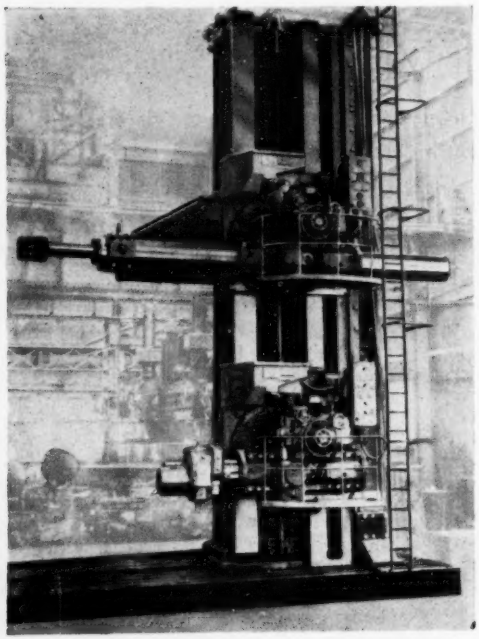


**Fig. 1. A General View of the Self-contained Portable Column Unit for a Large Craven 36-ft. Diameter Table Turning and Boring Mill**

Basically, this latest machine comprises a main machine bed which supports two concentric circular tables. The inner table, which is of 12 ft. diameter, is stationary, and is surrounded by a 36-ft. diameter, 12-ft. bore, outer rotating table. This outer table is supported and located on a flat outer track and a V-section inner track, and is driven by two variable-speed electric motors, each of 100 h.p., which are synchronized, electrically, to ensure that the load is equally shared between them. Each motor is coupled to its own 3-speed gearbox, whence drive is transmitted through a friction clutch to a pinion meshing with a 26-ft. diameter external spur ring bolted to the underside of the table.

All gear changing, and operation of the clutches, is effected electrically, and the speed range of the table can be varied steplessly between 0·15 and 3·5 r.p.m. In addition to normal continuous rotation, the drive is arranged, electrically, so that the outer table can be rotated partially, with automatic reversal, to enable isolated facings to be machined by a "planing" procedure.

## USE OF THE PORTABLE COLUMN

The portable column, a general view of which is shown in Fig. 1, can be applied to the basic machine in three separate ways. Firstly, the column can be mounted on the inner (stationary) table, and the workpiece clamped to the outer (rotating) table. With this arrangement, workpieces from 10 to 36-ft. diameter can be machined internally, or faced. Secondly, the column can be mounted on the outer table, and the stationary workpiece supported on foundation girders which extend radially from the main machine bed. With such a set-up, work can be bored or faced up to a maximum diameter of 64 ft. Thirdly, the column can be bolted to a T-slotted sub-base, which extends radially from the main bed, and the work mounted on the outer table. Workpieces from 11 to 64 ft. outside diameter can then be machined.

Designed so that it may be lifted by crane as a complete assembly, the column unit weighs

approximately 100 tons. It incorporates a column 27 ft. 6 in. high, which is built up from three separate box sections. There are two self-contained saddles arranged on the vertical ways of the column, and both are provided with octagonal-section rams. A swivelling adjustment is provided for each saddle, so that its ram can be inclined at a maximum angle of 30 deg. above or below the horizontal. Two interchangeable rams are supplied for each saddle, one having a longitudinal travel of 11 ft., and the other, which is for use in confined spaces, a travel of 2 ft. 6 in. A detachable, swivelling-type tool holder is available for each ram. Alternatively, the auxiliary self-contained milling head seen in Fig. 2 can be fitted either to the end face (as shown) or to any one of the eight faces of the octagonal section.

This milling head is powered by a separate 5-h.p. motor, and the four spindle speeds, which range from 30 to 90 r.p.m., are obtained by means of slip gears. A hand-operated adjustment of the head on the compound swivel-slide is provided, for initial positioning of the cutter.

Each of the saddles has its own 7½-h.p., constant-speed, feed and rapid traverse motor, and a gear-box gives a total of 12 vertical and 12 horizontal feed rates, to the saddle and ram, respectively. These rates range from 0·007 to 6 in. per min., and rapid traverse of 30 in. per min. is available in either direction.

Maximum reach of the rams is obtained by the use of extension bars, each fitted with its own adjustable tool head, and outboard supports are provided for the rams when they are used at maximum overhang. The minimum space in which the column can operate is 10 ft. diameter—when the short ram is in use and it is inclined at the maximum angle of 30 deg. An operator's platform which is provided on each saddle can be used even when the unit is being employed in the smallest space mentioned above, but the ladder which affords access to the platforms must be removed when working within spaces of less than 14 ft. diameter.

### ELECTRICAL CONNECTIONS AND CONTROLS

When the column is mounted on either the stationary inner table, or on the radially-extending sub-base attached to the main bed, the electrical supply is obtained by plugging-in to a socket which is provided on each of these members. If the column is used on the outer (rotating) table, however, the electrical supply is taken from a socket on the latter. This socket is supplied with current by an arrangement of brush gear and slip rings in the bore of the table.

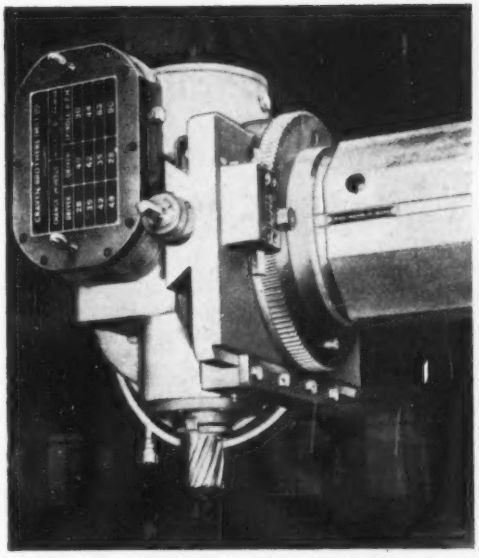


**Fig. 2. Close-up View of the Independently-driven Milling Head which can be Fitted to Either of the Octagonal-section Rams of the Column Unit. This Head is Powered by a 5-h.p. Motor**

There is a separate push-button station on each saddle casting, which includes controls for the table motors, for the feed and rapid traverse motor of the saddle in question, and for the milling head motor when the latter is in use. A further, portable, push-button panel is provided which can be used in an external position. This panel gives independent control of the table driving motors, when bores of smaller workpieces are machined.

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WAKEFIELD FLOATING GREASE PUMP—To facilitate the transfer of heavy grease from the containers in which it is supplied, Wakefield-Dick Industrial Oils, Ltd., 67 Grosvenor Street, London, W.1, have introduced a range of floating pumps. It is stated that these pumps are easily attached to containers, and in operation they "suck" their way downwards without causing channelling or cavitation. Containers can thus be completely emptied without risk of contaminating the grease. Two types are available, both of which operate on air pressures of 80 or 150 lb. per sq. in. The low pressure pump delivers grease at 400 lb. per sq. in., and the high pressure type, at 6,000 lb. per sq. in.

# Muschamp High-production Riveting Machine

The high-production, 2-line, riveting machine, seen in Fig. 1, has been designed and built by N. J. Muschamp & Co., Ltd., Mansfield Woodhouse, Notts., for operations on steel jibs for coal cutting machinery. These jibs normally have two rows of ½-in. diameter rivets, the rows being spaced at centres which range from 7 to 8¼ in., and the machine enables pairs of rivets, one in each row, to be heated and driven simultaneously. Alternatively, it can be set to deal with one rivet at a time.

Designed for installation in a production line, the machine has a horizontal work-table. This table is in the form of a conveyor, being provided with 12 free-running rollers, and can be adjusted through a maximum distance of 15 in. by a pair of pneumatic rams, the upper ends of which can be seen protruding from the top of the machine

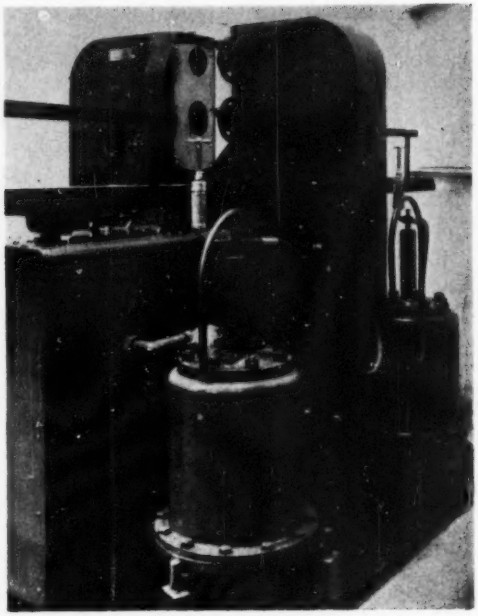


**Fig. 2. Rear View of the Riveting Machine Seen in Fig. 1 Showing the Pair of Broomwade 18-ton Hydro-pneumatic Squeeze Riveters**

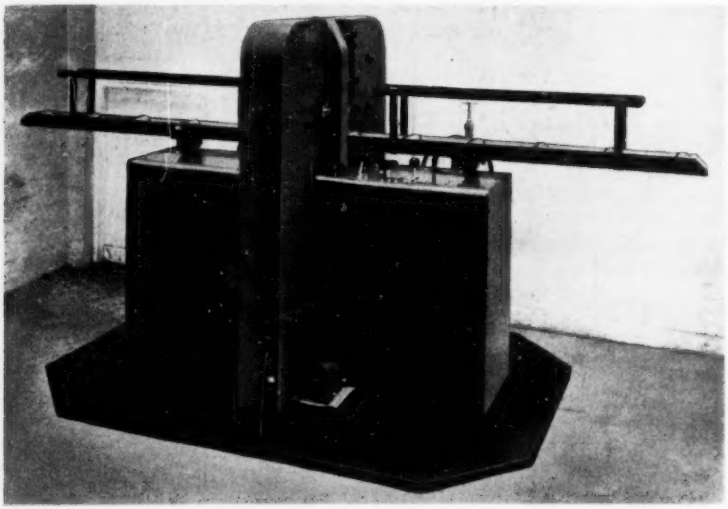


**Fig. 1. Muschamp High-production 2-line Riveting Machine for Coal-cutting Machine Jibs**

base at the left and right. The right-hand ram is coupled mechanically, by a roller chain, to the left-hand (slave) ram, so that the table is maintained in a horizontal plane as it is raised and lowered.

In operation, the rivets are assembled cold, and the work is passed along the conveyor/table and between the two columns of the machine, that nearest to the camera in Fig. 1 containing two flame rings which are supplied with a mixture of town's gas and oxygen. These rings can be seen more clearly in Fig. 2, which is a view from the rear of

the machine. A pair of backing-up snaps is provided in the other column, and these are adjustable in relation to the faces of the burner rings. The upper flame ring and backing-up snap are fixed, but the lower ring and snap can be adjusted vertically, simultaneously, by means of the hand wheel seen at the left of the control panel in Fig. 1. This adjustment allows jibs which have rows of rivets at various centres, within the capacity quoted above, to be accommodated.

Each ring directs a cone of flame on to the end of the rivet which is to be closed, and pressure is applied to the riveting snaps, which are mounted coaxial with the flame rings, by the two Broomwade 18-ton Hydro-pneumatic squeeze riveters, seen mounted on the base at the rear of the machine in Fig. 2. Control of the actual riveting operation is provided by the pedal visible in Fig. 1.

When it is required to close one row of rivets only, the handwheel in the centre of the control panel is used to cut-off the pressure supply to the lower riveting snap, and the adjacent ball-ended lever controls a valve which interrupts the supply of gas to the lower flame ring.

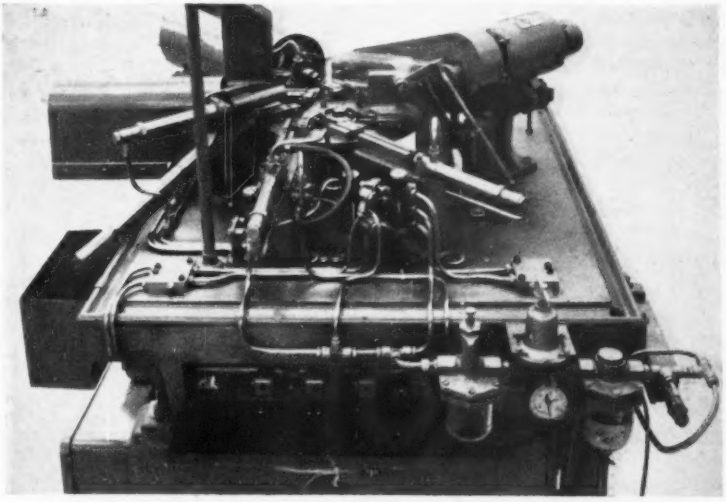
The taps seen on the side of the burner head column control the pilot flames for the rings.

# Special Rotary-indexing Machine for Operations on Fountain Pen Barrels

The special-purpose, fully-automatic, rotary-indexing machine shown in the accompanying figure has been designed and built by Bristol Repetition, Ltd., Feeder Road, Bristol, 2, for a number of operations on injection-moulded fountain pen barrels, and it is stated that it has enabled the production rate for the component to be increased by more than 600 per cent. There are eight stations, which provide for tapping, slotting, piercing, grooving, and cleaning operations, and the components are fed into the machine by means of the inclined hopper seen at the upper left.

On the top surface of a mark VII automation base, are mounted the various heads and the work carrier, and below the table there are three synchronized shafts, to which simple plate cams are fitted. These cams either actuate the tools direct, or are used to operate pneumatic or hydraulic valves, or electrical switches. In this case, use is made of Maxam (Climax Rock Drill Engineering, Ltd.), pneumatic equipment, and a number of the cylinders and control valves, also the pressure regulator, lubricator, and filter for the incoming air, can be seen in the foreground.

As already mentioned, the components are fed from a hopper at station (1), where an air cylinder subsequently pushes each part into a simple fixture in which it is clamped. At station (2), a thread is tapped, in the bore of the part, and, simul-



**Close-up View of an 8-station, Rotary-indexing, Fully-automatic Machine for Performing a Number of Operations on Injection-moulded Fountain Pen Barrels. The Machine Incorporates a Standard Compass Mark VII Automation Base (Bristol Repetition, Ltd.) and Maxam Pneumatic Equipment is Employed**

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taneously, a milling cutter mounted on a spindle disposed at 90 deg. to that of the tapping head, is fed down to mill a narrow slot for the filler-lever. Station (3) is idle, and at station (4) a large-diameter cutter is plunge-fed to mill a thumb groove, which surrounds the slot produced at station (2). At the same time, a cutter is advanced into the bore of the barrel, to a predetermined depth. This cutter is of the expanding type and produces an annular groove in the bore, after which it is automatically contracted and withdrawn.

A piercing tool at station (5) squares-off the end of the narrow slot nearest to the open end of the barrel, and the sixth and seventh stations provide for cleaning. A probe is introduced into the bore at each station, blasts of compressed air are applied to remove the swarf, and a rubber pad serves to clean the outside surface of the part. Finally, at station (8), the part is automatically ejected from the machine, and discharged by way of a chute into the work pan seen at the extreme left.

It is stated that the Compass base affords a considerable measure of adaptability. It can be used, as here shown, in conjunction with air-operated equipment, and can be re-tooled readily for design changes, or for operations on other parts.

## Solus Schall "Rod Anode" X-ray Unit

The 150-kV. X-ray unit shown in Fig. 2 has been introduced by Solus Schall, Ltd., 15-18 Clipstone Street, Portland Street, London, W.1. A feature of this unit is a "rod anode" X-ray tube which may be used in confined spaces such as bores of fairly small diameter. The rod anode tube is seen in Fig. 1, removed from its shield.

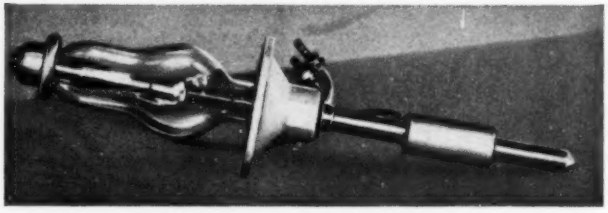


**Fig. 1. The "Rod Anode," which can be used in Confined Spaces, is here shown with the Shield Removed**

In operation, the stream of electrons is passed down the tubular anode and directed on to a target at one end, and the resulting X-rays are then discharged radially from the tube. If required, a lead cover incorporating a window can be passed over the end of the tube so that the X-rays are emitted in one direction only. Since the voltage applied to the X-ray tube is unipolar and constant, the target is at earth potential and may be positioned close to the work.

The X-ray tube assembly is attached to an arm which can be adjusted on a cylindrical column. Other equipment mounted on the wheeled base, which is fitted with a towing handle, comprises a high-voltage transformer and a smoothing capacitor housed in a single oil-filled tank, a pump unit for delivering oil to the X-ray tube, for cooling purposes, and a control unit.

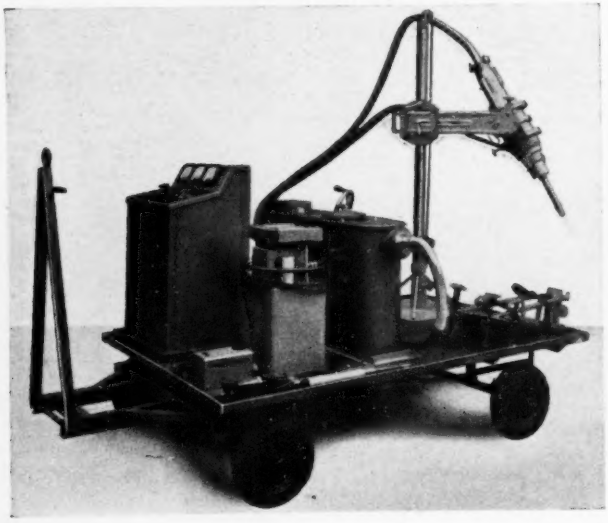


**Fig. 2. Solus Schall 150-kV. "Rod Anode" Transportable X-ray Unit**

# Reorganization of a Swedish Motor Vehicle Factory

An extensive long-term programme of expansion and reorganization is in progress at the works of A-B. Scania-Vabis, Södertälje, Sweden, where some 3,000 employees are directly engaged in producing the firm's range of diesel engines, buses, and heavy vehicles. At present, the output exceeds 4,500 vehicles and 1,000 stationary engines annually. In carrying out this programme, the firm is following a policy of setting-up individual self-contained factories, each devoted exclusively to the production of a particular type of major unit. Product design, tooling, and all matters relating to the product, will be the responsibility of the factory concerned. Among the objects of this policy may be mentioned the attainment of a closer co-ordination of all aspects of design and production; a higher degree of organization and specialization; a concentration of specialized knowledge; and a clearer division of responsibility. Each factory will be designed and built to meet the specific requirements for the particular type of product.

A new factory for producing transmissions is already in operation, and provides a floor space of 107,640 sq. ft. It is also planned, during this year, to transfer the bodywork and engine sections to their respective new buildings. The equipment of the new transmissions factory includes some 300 machines, with extensive mechanization, and various automatic safety devices. Automatic devices are also provided, which detect and counteract, at short notice, incipient interruptions to production flow, in those sections liable to breakdown.

A view of part of the large machine-shops is given in Fig. 1 in which may be seen the system of air-extraction trunking that provides for the removal of dust at each machine. The machine lines are served by power conveyors arranged below floor-level, which carry the swarf to a crusher.

The transmission plant is the first factory in Sweden to incorporate a centralized coolant-supply system in a building designed specifically to accommodate it. In cellars beneath the building, shown in Fig. 3, there are three 15,300-gal. settling-tanks, from which the coolant is circulated through pipe-line loops in the roof of the machine-shop. At appropriate distribution-points in the machine bays, the loops descend to floor level, whence the coolant is fed to the individual machines. In this way, a constant supply of clean coolant to each machine is ensured, and the necessity for individual floor tanks is avoided. After use, the coolant is returned to the main tanks, through a system of draining channels in the shop floor. For these and other tanks, for diesel-oil and quenching oil, there are filler cocks to which the road tankers that deliver the oil are directly coupled. Metering is effected automatically, and the flow is cut off when the required volume has been delivered. Meanwhile, dial instruments at

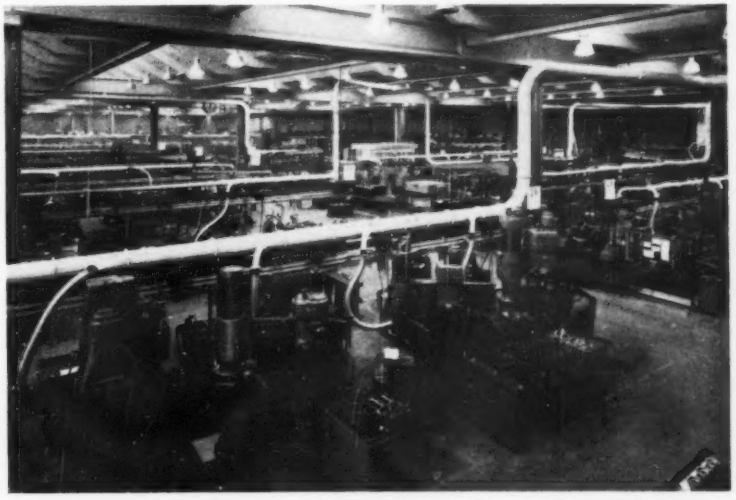


**Fig. 1. Part of the Large Machine-shop in the New Transmission Factory of A-B. Scania-Vabis, Sweden, showing the Orderly Layout and the Trunking for Dust-removal**

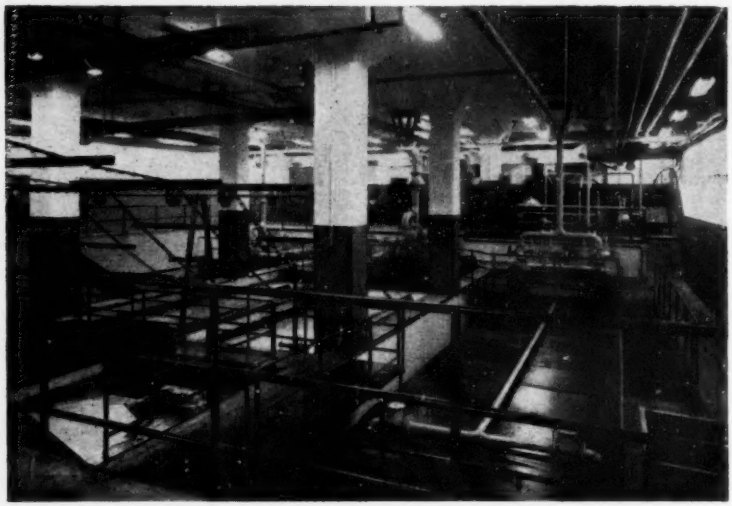


**Fig. 3. In Cellars Beneath the Building, Here Shown, are Installed the Large Settling-tanks for the Centralized Coolant Supply System**

the filler cocks serve to indicate the contents of the various tanks.

The equipment of the new factory includes an extensive heat-treatment section, in which there are large hardening furnaces with comprehensive instrumentation for accurate process control, and fully-automatic furnaces of the type shown in Fig. 2. This particular furnace is employed for the heat-treatment of forgings, and the process is carried out at night. Batches of forgings are loaded on to the annular conveyor, and the equipment is set in operation approximately at midnight. The conveyor carries the work through the chamber of the furnace which operates unattended until 5 a.m. the following morning, and by this time, the treated components are delivered in readiness for the day's work.

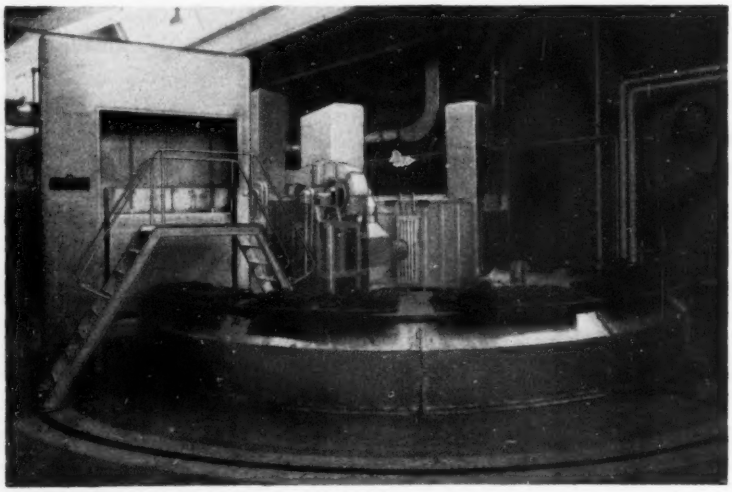


**Fig. 2. This Fully-automatic Furnace, in the Extensive Heat-treatment Section, Operates Unattended at Night and Delivers Processed Components in Readiness for the Next Day's Work**

The gases employed to maintain a non-oxidising atmosphere in the hardening furnaces contain a proportion of carbon monoxide, and as a safeguard against the possibility of the air in the factory becoming contaminated, a special warning system has been installed. Should the concentration of carbon monoxide in the air exceed 1:5,000, an alarm is automatically sounded throughout the building.

Other emergency equipment provided includes a diesel-driven generating plant, which comes into action automatically within 7 sec. in the event of a power failure. This plant supplies the necessary current for lighting, and for the various furnaces. Should there be a failure of the water supply, a reservoir associated with the factory is replenished at the rate of 155 gal. per min., from a 98-ft. well.

# Induction Heating for Shrink-fitting

By D. W. THOMAS*

Shrink-fitting, once regarded as an excellent but costly method of assembly, becomes a practical manufacturing technique when induction heating is employed.

In shrink-fitting, as a rule, two cylindrical parts are involved, the outside of one part being assembled to the bore of the other. The outside diameter of the inner part is machined slightly larger than the bore of the external part. To obtain the shrink-fit, the inner part is cooled to decrease its diameter, and, at the same time, the external part is heated to increase its diameter. While the one is cool and the other is hot, they are fitted together and allowed to return to room temperature.

Sometimes, cooling of the inner part can be eliminated if enough heat can be applied to the external part quickly, and in such a manner that no undesirable changes take place.

In the past, shrink-fit assemblies were found only in precision equipment such as machine tools. To hold the necessarily close limits on the dimensions of the mating portions of the members was too costly for ordinary manufacturing assemblies. With the great improvement in metal working practice over the past 20 years, however, closer tolerances can now be held without appreciable increase in cost. Consequently, shrink-fit assemblies are becoming increasingly competitive with standard fastening devices. This statement applies particularly where induction heating equipment has been installed. Many parts can now be heated in a few seconds.

When such rapid heating is possible, a complete assembly frequently can be made in 8 to 15 sec. By contrast, the external member formerly had to be heated in a furnace for two hours, and the internal member has to be refrigerated for four to six hours.

At one of the works of the General Electric Co., U.S.A., a stator is shrink-fitted to the motor housing for an appliance in an assembly cycle time of 18 sec. In this instance, the usual fastening devices—three long bolts, nut, and washers—have been eliminated. Savings in time and material, as compared with the former assembly method, prompted the company to adopt the technique for another appliance. In this second application, compressors and stators are shrink-fitted to housings, and compressor shafts are shrink-fitted to rotors.

Some motor car companies are shrink-fitting ring gears to flywheels. Tractor manufacturers are using shrink-fits for the assembly of main drive gears to hubs, and pulleys to shafts. In addition, steering knuckles are being shrink-fitted to steering knuckle posts, a press-fitting operation which involved a scrap loss of 10 per cent having thus been eliminated. In another instance, an average of 70 defective assemblies per week was virtually eliminated by a commercial refrigeration manufacturer, when press-fitting of stators to housings was abandoned in favour of shrink-fitting.

The controlling factor in shrink-fitting is usually the length of the heating interval, which depends largely on the amount of interference between the parts, and this, in turn, is determined by the pressure required. For thick, hollow cylinders under external and internal pressure, the equation for this force is:

$$P = \frac{E\Delta}{B} \frac{(B^2 - A^2)\ (C^2 - B^2)}{2B^2\ (C^2 - A^2)}$$

where $P$ = pressure in lb. per sq. in.;
$E$ = modulus of elasticity;
$A$ = inner radius of inner cylinder;
$B$ = outer radius of inner cylinder;
$C$ = outer radius of outer cylinder;
$\Delta$ = actual interference between the cylinders.

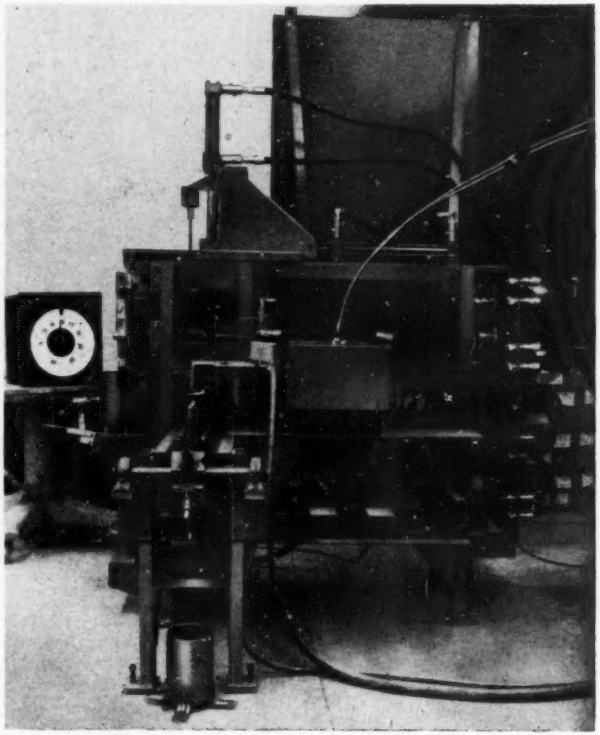
This force should be kept to a minimum to reduce the heating time and the risk of fractures occurring because parts have been over-stressed. Under all conditions, however, the maximum stress theory should be applied to provide a fast check on good design practice. Maximum tensile stress on the inner surface in a tangential direction can be calculated for thick, hollow cylinders from this equation:

$$St = P\ (A^2 + B^2)/(B^2 - A^2)$$

where $St$ = maximum tensile stress;
$P$ = pressure in lb. per sq. in. (found from the preceding equation);
$A$ = inside radius;
$B$ = outside radius.

For the cylinder subjected to external pressure,

* General Electric Co., U.S.A.



**Rotors are Shrink-fitted to Shafts on a Production line Basis. With this Equipment a 40-kW Induction Heater Raises the Work to 650 deg. F., and One Assembly is Produced every 20 sec.**

the maximum compressive stress on the inner surface is:

$$Sc = 2PB^2/(B^2 - A^2)$$

where $Sc$ = maximum compressive stress.

As the required pressure decreases, lower temperatures, involving less heating time, are needed. Lower working temperatures facilitate material handling and there is less distortion due to heating. Thinner cylinder wall sections can be used with lower pressures, and the volume of metal to be heated is therefore reduced.

The temperature which the outer cylinder must reach is based on the coefficient of linear expansion of the metal involved and the interference between the parts. The approximate coefficients of linear expansion for some of the standard production shrink-fit materials, per degree up to 725 deg. F., are:

| | |
|---|---|
| Aluminium ... ... | $9{\cdot}4 \times 10^{-6}$ |
| Grey cast iron ... ... | $5{\cdot}89 \times 10^{-6}$ |
| Wrought iron ... ... | $6{\cdot}33 \times 10^{-6}$ |
| Brass ... ... ... | $10{\cdot}4 \times 10^{-6}$ |
| Steel ... ... | $5{\cdot}6$ to $7{\cdot}3 \times 10^{-6}$ |

For most applications, an induction heater of suitable kilowatt rating should be used with a multiple-turn, loosely coupled, high-voltage coil. Such a set-up provides a fast heating cycle. At the same time, the power density is limited to prevent overheating. Frequency may also be important. In general, the thicker the wall, the lower should be the frequency, because lower frequencies provide deeper current penetration. The correct frequency is determined by the size of the parts to be heated.

Cooling time must be sufficient to allow the outer cylinder to shrink on to the inner with enough force to preserve any specific relation between the parts.

The duration of the shrink-fitting cycle also depends, of course, on the nature of the equipment provided for assembling the parts. This equipment may range from a plain arbor press or air cylinder, to a completely mechanized machine, as seen in the accompanying illustration, according to production requirements.

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SMALL INJECTION-MOULDED NYLON PARTS. A high-speed single-impression injection moulding technique has been developed by George Goodman Ltd., Robin Hood Lane, Hall Green, Birmingham 28, for the quantity production of very small parts in Nylon. These parts, which are known as GG MiniMouldings, include such items as gears, threaded fasteners, chain links, coil bobbins, and sprockets. The maximum weight which can be moulded is 0·05 oz., and the maximum length, 1⅝ in. For cored parts, the minimum bore size is 0·015 in., and the minimum wall thickness, 0·008 in. The technique also provides for automatic insert moulding, with individual or continuous inserts, which may take the form of threaded parts, stampings, wire, or tape, for example. The Nylon employed for these mouldings is I.C.I. A.100, which has a tensile strength of 11,500 lb. per sq. in., and a Vickers hardness of 12.

# News of the Industry

## Halifax

WILLIAM ASQUITH, LTD., have a number of large and special-type machine tools in progress, in addition to their standard radial, vertical and transportable drilling machines. The fourth and fifth of the 10-in. spindle ram-type horizontal milling and boring machines are now nearing completion at the Shrewsbury works, and orders are in hand for a batch of 7-in. spindle machines, also a 6-in. spindle machine, which is destined for Canada. Conventional-type horizontal boring machines, with spindles from 4 to 7 in. diameter, are in good request. Other interesting machines on order include a diesel engine cylinder block boring machine for the North British Locomotive Co., Ltd., Glasgow; a 30-ft. single-ended tube boring machine; and a vertical boring machine for Doxford engine cylinder liners for Barclay, Curle, Ltd., Glasgow.

Our attention was drawn to a recently-developed girder end facing machine, on which cemented-carbide cutters will be used, for structural steelworks. The first machine has recently been supplied to Downays, Ltd., Welwyn Garden City, and we hope to describe it in due course. A transfer-type machine is on order for the Austin Motor Co., Ltd., Birmingham, for operations on cylinder blocks and crankcases, and a 100-ton boring and facing machine in hand, for Metropolitan-Vickers Electrical Co., Ltd., Manchester, will be employed for machining low-pressure turbine casings. In connection with the large contract for machine tools for the central maintenance workshops of the Durangpur steelworks, India, we are informed that 75 per cent of the plant has now been despatched, and the firm's engineers are on the way to start installation. Among recent additions to the plant at the Halifax works is a Ceruti 5-in. spindle, table-type, horizontal boring machine, a Kearns Optimetric horizontal boring machine, a Butler 26-in. stroke shaping machine, a Swift lathe and a Precimax cylindrical grinding machine. Considerable extensions are in progress at the works of the associated Modern Foundries, Ltd.

THE BUTLER MACHINE TOOL CO., LTD., have a good order book for planing, shaping and slotting machines for customers both at home and abroad. Spiral electric double-standard planing machines in hand range up to 10 ft. wide and openside-type machines up to 7 ft. wide. We may also note that rail and axle-box planers are on order, together with 36-in. stroke openside crank-type, and 30-in. square by 6- and 8-ft. stroke hydraulic openside planers. Shaping machines in progress include 18- and 26-in. stroke Super types, and 18-in. stroke hydraulic machines. In addition, high precision slotting machines of 8-, 12- and 16-in. stroke, high-production machines of 14- to 36-in. stroke, and puncher-type machines up to 54-in. stroke are on order. The principal export markets include Australia, South Africa, and France.

FREDK. TOWN & SONS, LTD., are actively engaged in the production of standard and girder-type radial drilling machines in sizes ranging from 3 to 8 ft. radius. We may also note that medium- and heavy-duty box body vertical drilling machines are

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**This air-cooled diesel engine, type HA3, has recently been added to the extensive range made by R. A. Lister & Co, Ltd., Dursley, Glos., and is intended for a wide variety of industrial, marine, and agricultural applications. It is available in 2- and 3-cylinder designs which provide outputs of 20 and 30 h.p. at a speed of 1,800 r.p.m. The company have also developed a new range of smaller engines, and these are made in 1-, 2-, and 3-cylinder types, with ratings from 12¾ to 41 h.p.**

in progress. A good proportion of the firm's output is destined for overseas markets.

CHURCHILL-REDMAN, LTD., are occupied on orders for Churchill-Fay multi-tool lathes, hydraulic profiling lathes, heavy-duty lathes, and shaping machines. Our attention was drawn to a batch of the new P.5 automatic multi-tool and profile turning lathes in progress. This machine was described in MACHINERY, 92/570—7/3/58. In course of development are new designs of 18- and 22-in. swing general-purpose lathes, which we hope to describe in due course.

KITCHEN & WADE, LTD., are building radial drilling machines up to 12-ft. radius, vertical drilling machines, horizontal drilling and boring machines, and honing machines. Unit heads for drilling, boring and milling, for supply as units or built into machines, are in good request, as are hydraulic multi-spindle drilling machines. Our attention was drawn to a recently-developed, 3½-in. spindle, table-type horizontal borer, to which we hope to make further reference shortly. Among the special machines on order we noted two 4-in. spindle sliding-head boring machines, duplex head pipe facing machines, and a girder end face milling machine with a 4-ft. diameter cutter head. The firm's recently introduced precision-type "drill boring machine will be described in the near future. Chip crushing machines formerly made by Carter & Wright (Engineers & Machine Tools), Ltd., are now being produced at these works.

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**At the works of the Hoffmann Manufacturing Co., Ltd., high-speed Fay lathes, each driven by a 50-h.p. motor, and equipped with carbide form-tools, are employed for machining the tracks in ball and roller bearing races up to 9¾ in. diameter. Tools with chip-breakers cannot satisfactorily be used for this purpose. An indication of the high rate of metal-removal is afforded by the accompanying illustration, in which is seen the result of approximately half an hour's machining, on 8¾-in. diameter inner ball races. The stage is completed on each component in a floor-to-floor time of 38 sec., and the work is run at 358 r.p.m.**

GRAHAM & NORMANTON, LTD., have received orders for six 15½-in. centre break lathes for the central maintenance workshops of the National Coal Board and an article describing one of these machines will be published shortly. In addition to standard lathes of 9-, 11- and 13-in. centres, in progress, we may note orders for a 19-in. centre, two-saddle lathe, with special grinding attachment, for machining tube mandrels, and a combined 23-in. centre turning and boring lathe. Two 84-in. diameter roll trimmers and two 28-in. stroke shaping machines have recently been despatched to Iran. New types of 11-in. and 13-in. centre heavy-duty lathes, which have been developed, will be described in a future issue. Export orders have recently been received from Australia, Trinidad and British Guiana.

AUGUSTS, LTD., are well employed on the production of foundry mechanization equipment, particularly for malleable iron foundries. There is also a steady demand for August-Simpson foundry sand and refractory preparation plants, the range of these machines having recently been extended.

F. PRATT & CO., LTD., are doing a good business in their various types of independent and self-centring lathe chucks, and faceplate jaws, on both home and export account. There is also a brisk demand for circular and rectangular permanent magnet chucks, air and hydraulic chucks, pneumatic machine vices, Woodworth air-operated diaphragm chucks, and stationary oil-hydraulic cylinders.

AJAX MACHINE TOOL CO., LTD., report a well-maintained demand for bench- and column-type drilling machines, bench- and pedestal-mounted milling machines, polishing heads, second-operation machines, and universal converters. Radial drilling machines of 54- to 66-in. radius, girder-type machines from 6- to 8-ft. radius, and the latest elevating-table machines of 36- and 48-in. radii are also in good request. Some of the machines on order are destined for overseas markets.

WRIGHT ELECTRIC MOTORS (HALIFAX) LTD.,

have a variety of electric motors in progress, including a batch of haulage motors for the National Coal Board, woodworking machinery motors, and Kopp speed variator motors. Diesel engine generating sets on order include three for Pakistan. There is a steady demand for the various types of Electro-suds pumps from the machine tool industry, and orders for table surface grinding machines with 8- to 20-in. diameter wheels, and for motorized grinding heads, are maintained at a satisfactory level. Table surface grinders and grinding heads are being shown at the Brussels World Fair on the Birmingham Engineering Group Stand.

FRED WHITELEY, LTD., are experiencing a good call for machinery guards and sheet metal components, the latter including metal frameworks for fluorescent electric lamps, shelving and bins for the coal mining industry, clothes lockers of various sizes, and separator plates for the textile machinery trade. A Butterley 40-ton inclinable power press has recently been added to the plant. H. B.

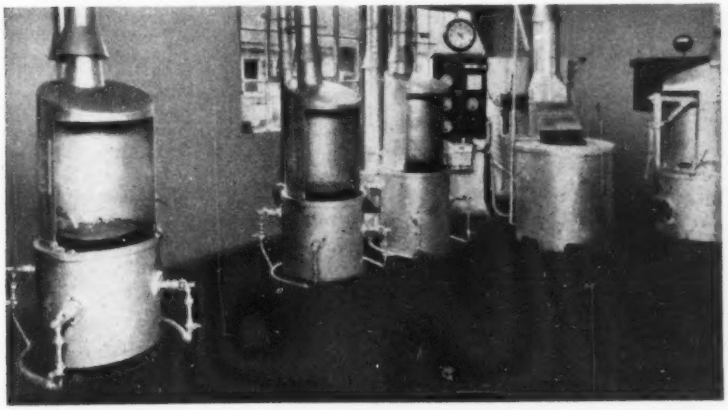
## The South

THE ACCLIM CO., LTD., Hoddesdon, Herts, report an expanding home and export demand for their range of high-speed steel, ground thread taps and other screwing tools. Additional premises have recently been acquired, and a complete Birlec-Cassel salt bath plant for high-speed steel heat treatment and surface treatment, as shown in the figure, has been installed, and is now in full operation.

Hardening is carried out under strict metallurgical control, and the new plant will enable output to be increased, and will facilitate the maintenance of a high standard of quality.

SOUTHERN INSTRUMENTS INDUSTRIAL DIVISION, Frimley Road, Camberley, Surrey, report that sales of the Magna-Gage electronic gauging equipment are increasing at a satisfactory rate and that the demand from the U.S.A. is particularly good. A Magna-Gage electronic comparator has been successfully employed for automatic size control on a spherical grinding machine and enables components to be produced to a tolerance of 0·0001 in., with a semi-skilled operator. In another instance, these comparators are being used by a company making semi-conductors. The light probe pressure, it is stated, enables the thickness of germanium wafers to be measured without damaging the surfaces. The equipment is also used with probe units attached to leads up to 36 ft. long, for remote gauging. Development work is proceeding with a view to increasing the field of application for this comparator.

PEPPERS OF WOKING, LTD., Stanhope Road, Camberley, Surrey, have specialized, for more than 25 years, in the design and construction of switching equipment and cubicles for a wide range of applications, to customers' requirements. Work at present in progress includes fuse and distribution boxes for marine installations to Lloyd's specifications, and comprehensive control equipment for a large chip-board plant which is to be erected in Europe. The latter, it is stated, will have a greater degree of automatic control than has previously been provided for such a plant. The company, and a branch at Woking, have facilities for press work up to 20 tons rating; general machining; sheet metal fabrication; turning on centre and capstan lathes; and the construction of special tooling. A modern bus-bar trunking system installed in the main shop enables machine tools to be rearranged, when necessary, without interrupting production. At present, 20 apprentices are receiving instruction in the works.



**A View of the New High Speed Steel Hardening Plant at the Works of the Acclim Co., Ltd.**

KINETROL, LTD., Trading Estate, Farn-

ham, Surrey, who were established recently, will be concerned, among other activities, with the design and production of automatic control equipment for machine tools and plant used for processing a wide range of materials. In this connection, it may be noted, the company is developing digital positioning equipment for machine tool applications. The production, on a limited scale, of other engineering products is at present being undertaken, including a fine wire feeder, and a precision dash-pot. These items will be described later in MACHINERY. A tachometer, which incorporates a photo-electric cell and transistors, and is completely self-contained, has recently been introduced. F. W. H.

## Peco Injection Moulding Machine

Recently introduced by Projectile & Engineering Co., Ltd., Thessaly Road, London, S.W.8, the Peco type 60MP60 injection moulding machine, here illustrated, will handle up to 60 oz. of polystyrene, or, when a different injection chamber is fitted, up to 83 oz. of polythene per shot.

A mould closing force of 750 tons is applied to the moving platen by a hydraulically-operated toggle mechanism, and the working stroke can be varied from 21 to 32 in. by adjusting a screw stop. Setting of the moving platen, to suit moulds with shut heights ranging from 19 to 36 in., is obtained by means of a large-diameter central screw with buttress-form threads, provision being made for turning the mating nut either by hand, or by a push-button controlled motor through worm gearing. The moving platen and back plate slide on flat ways on the bed, and are guided by four large-diameter, high-tensile steel, tie bars. The platens have a working surface of 54 by 56 in., and the space between the tie bars is 37¼ by 40¾ in. If required, the upper tie bars may be removed to facilitate mounting and removing large moulds. A 50-h.p. motor drives the hydraulic pump.

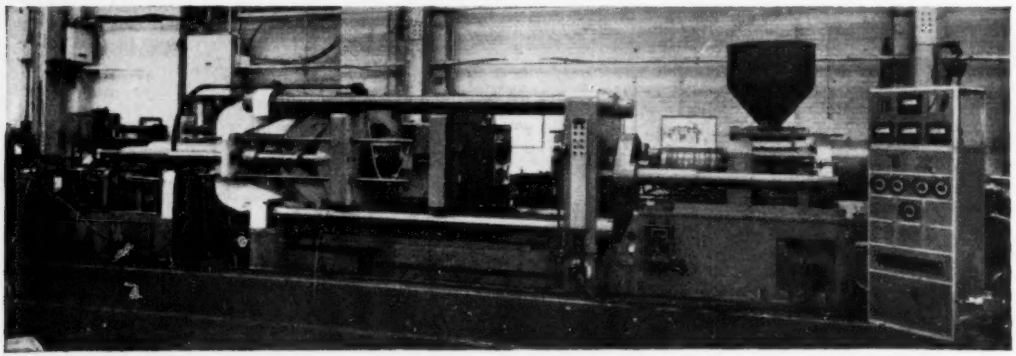
The injection unit incorporates an in-line pre-plasticizer of the well-established Peco design, which will handle 200 lb. of material per hour. During the curing stage of the moulding cycle, plastics material is fed to this unit from a hopper of 300 lb. capacity, by a hydraulic ram, under a pressure of 9,770 lb. per sq. in., and is then plasticized in readiness for the next cycle. The heating elements for the pre-plasticizer have a power consumption of 25½ kW. A force of 229,280 lb. is applied to the 5-in. diameter plunger, which has a stroke of 5⅝ in., and provides for injection of material into the mould cavity at the rate of 39·1 cu. in. per sec.

Peco injection moulding machines are handled by Peco Machinery Sales (Wesminster), Ltd., 28 Victoria Street, London, S.W.1.

## Revised Strategic Embargo Trade Lists

A revised list of goods subject to embargo for export to countries in the Soviet Bloc, and China, has recently been issued by the Board of Trade.

Machine tools now freed from control include; vertical boring and turning mills; horizontal boring, drilling and milling machines; jig boring and jig grinding machines with no traverse exceeding 44 in.; contour profile grinders; "lap radial grinders"; roll grinding machines; thread grinding machines; most lathes (except right-angle lathes specially designed for gas turbine work, and spinning lathes); thread milling machines; planing machines and plano-millers; forging hammers up to 10 tons (except certain counterblow hammers and horizontal impact hammers); forging machines;



**Peco type 60MP60 injection moulding machine**

mechanical or hydraulic presses up to 5,000 tons; and most gear-making machinery (except generating type grinders for gears of 36 in. diameter and over, and machinery for the production of gears of module finer than 0·5).

It may also be noted that industrial diamonds and diamond tools, and almost all industrial types of ball and roller bearings, have been freed.

Among machines still subject to embargo, the following may be noted: deep-hole drilling machines of the kind designed to use tubular drills or bars in which the coolant passes through the drill or bar; internal grinding machines "of the kinds incorporating or specially designed for the utilization of grinding heads designed or rated for operation at speeds in excess of 80,000 r.p.m.," and milling machines having a travelling head, or heads, capable of milling aircraft spars.

New items added to the embargo list include machines incorporating electronic closed-loop feed-back controls "in which a continuous feed-back of information from the workpiece or tool or workpiece carrier or tool-holder itself results in continuous correction of the control commands."

Applications for export licences should be addressed to the Export Licensing Branch, Board of Trade, Gavrelle House, 14 Bunhill Row, London, E.C.1, from whom copies of detailed embargo lists can be obtained.

## Trade Publications

WORCESTER ROYAL PORCELAIN CO., LTD., Industrial Ceramics Division, Tonyrefail, Glam. Illustrated catalogue showing examples of a large number of parts which have been made for the textile, engineering, chemical, and electrical industries from Regalox sintered alumina ceramic. An article on this material was published in MACHINERY, 91/1490—27/12/57.

MIDLAND PNEUMATIC, LTD., New Cross, Wolverhampton, Staffs. Well arranged and fully illustrated catalogue concerned with the company's standard products. Air cylinders up to 8 in. bore, pilot valves, automatic control valves of many types, and pipe-line fittings are included in the wide range of pneumatic appliances described. Provision is made for the addition of extra pages, as and when fresh items of equipment are introduced.

ROCKWELL MACHINE TOOL CO., LTD., Welsh Harp, Edgware Road, London, N.W.2. Illustrated leaflet describing the British-built U.S. Multi-Slide machines, types 28 and 35. These machines are designed for the production of intricate stampings from coiled stock, in one operation, and incorporate four forming slides and up to four die heads. A wide range of auxiliary equipment is available, including a toggle press, positive blank holder, front and rear cut-off slides, and a tapping head. Both these machines were demonstrated at the recent Gauge and Tool Exhibition at Olympia, and were described in MACHINERY, 92/1078—9/5/58.

## Machine Tool Exports and Imports

EXPORTS OF MACHINE TOOLS

| Type of Machine | Month ended May 31 1958 | Five months ended May 31 | |
|---|---|---|---|
| | | 1957 | 1958 |
| | Value £ | Value £ | Value £ |
| New, complete— | | | |
| Boring machines: | | | |
| Vertical | 78,310 | 147,434 | 188,733 |
| Other | 137,647 | 455,611 | 411,615 |
| Drilling machines | 137,676 | 985,465 | 798,267 |
| Grinding (excluding thread grinding), lapping and honing machines | 244,130 | 1,151,144 | 970,575 |
| Lathes: | | | |
| Automatic | 136,649 | 852,068 | 642,542 |
| Capstan | 199,092 | 1,225,849 | 941,847 |
| Other | 306,800 | 1,313,625 | 1,269,214 |
| Screwing machines | 27,526 | 106,788 | 105,219 |
| Threading machines | 43,092 | 294,472 | 180,442 |
| Milling machines (excluding thread-milling) and gear cutting machines | 182,462 | 1,032,715 | 1,005,274 |
| Planing, shaping and slotting machines | 116,796 | 324,827 | 425,409 |
| Presses: | | | |
| Hydraulic | 41,299 | 527,543 | 249,390 |
| Other | 76,528 | 311,997 | 527,052 |
| Punching and shearing machines | 41,729 | 206,466 | 195,836 |
| Other plate and sheet metal-working machines including straightening rolls | 139,507 | 172,787 | 321,556 |
| All other machines | 205,288 | 1,399,476 | 1,170,992 |
| Used machines, complete | 64,003 | 284,768 | 318,170 |
| Parts | 196,751 | 968,710 | 965,756 |
| Total | 2,375,285 | 11,761,745 | 10,687,889 |
| *Destination* | | | |
| Union of South Africa | 107,443 | 602,862 | 751,323 |
| India | 514,962 | 1,614,199 | 1,763,011 |
| Australia | 230,998 | 1,657,149 | 1,501,323 |
| New Zealand | 20,383 | 159,786 | 167,867 |
| Canada | 132,965 | 783,038 | 773,551 |
| Other Commonwealth countries | 156,686 | 688,585 | 745,073 |
| Soviet Union | — | 540,181 | 63,858 |
| Sweden | 17,444 | 367,708 | 212,703 |
| Western Germany | 108,476 | 253,711 | 270,300 |
| Netherlands | 34,861 | 412,791 | 238,025 |
| France | 165,915 | 896,658 | 859,903 |
| Spain | 289,473 | 647,394 | 722,954 |
| Italy | 82,815 | 372,759 | 427,150 |
| U.S. America | 136,745 | 1,178,274 | 594,914 |
| Other foreign countries | 376,119 | 1,586,650 | 1,595,934 |

IMPORTS OF MACHINE TOOLS

| | | | |
|---|---|---|---|
| New, complete— | | | |
| Boring machines | 99,519 | 1,105,072 | 463,547 |
| Drilling machines | 6,751 | 187,448 | 98,042 |
| Gear-cutting machines | 94,644 | 548,809 | 290,678 |
| Grinding, lapping and honing machines | 183,078 | 1,071,798 | 1,046,273 |
| Lathes: | | | |
| Automatic | 146,563 | 932,305 | 1,162,360 |
| Other | 12,562 | 120,472 | 119,041 |
| Milling machines | 165,280 | 1,009,063 | 939,086 |
| Planing, shaping and slotting machines | 26,513 | 166,888 | 100,622 |
| Presses | 102,954 | 379,139 | 381,026 |
| All other machines | 334,801 | 1,974,633 | 1,798,090 |
| Used machines, complete | 9,597 | 114,742 | 246,007 |
| Parts | 243,464 | 1,875,169 | 1,418,382 |
| Total | 1,425,726 | 9,485,538 | 8,063,154 |
| *Country of Origin* | | | |
| Western Germany | 465,628 | 3,921,590 | 2,802,216 |
| Switzerland | 216,680 | 1,050,175 | 1,276,883 |
| U.S. America | 539,903 | 3,074,056 | 2,327,509 |
| Other foreign countries | 203,515 | 1,439,717 | 1,656,546 |

# Industrial Notes

E.M.I. ELECTRONICS, LTD., Hayes, Middlesex, report that recent export orders for electronic machine tool controls include one from Italy for a system to be fitted to a Cincinnati No. 3 milling machine, and one from Holland for table positioning equipment.

A. D. TACK RAGS & ADHESIVE DUSTERS, LTD., inform us that, in order to reflect their widening activities, the name of the company has been changed to Anti-Dust Services, Ltd. The address, as hisherto, is P.O. Box No. 28, Stafford Street, Dudley, Worcs.

FRED FERRARIS (CLERKENWELL), LTD., 14 Northampton Square, London, E.C.1, have recently taken up agencies for the following additional Swiss products: Sixis milling machines; Moser jig borers and multi-purpose machines; and Schemama depth collets. Descriptive leaflets covering these items are obtainable from the above address.

HONEYWELL CONTROLS, LTD.—The new head office building at Greenford, Middlesex, was officially opened recently by the chairman of the Honeywell organization of America, with which the English company is associated. Manufacture of instruments was begun in this country eight years ago, and 166,000 sq. ft. of factory space is now available for this purpose.

JOHNSON, MATTHEY & CO., LTD., 73 Hatton Garden, London, E.C.1, are to issue a series of technical data sheets giving comprehensive information on low temperature silver brazing operations. Applications for these sheets, from those who are not already on the company's mailing list, should be made to the publicity department at the above address.

THE INCANDESCENT HEAT CO., LTD., Smethwick, have formed a Gas Atmospheres Division for the purpose of co-ordinating the activities of the Incandescent Group in this particular field. Mr. I. L. S. Golding is in charge of the new division, which is responsible for the design, development, and sales of gas and controlled-atmosphere generators and gas dryers.

THE SOLARTRON ELECTRONIC GROUP, LTD., Thames Ditton, Surrey, are to hold two exhibitions in Scotland, at which the full range of their electronic precision instruments will be shown. The first will take place at the North British Hotel, Edinburgh, from August 25 to 27, and the second, at the George Hotel, Glasgow, from August 28 to 29, all dates inclusive.

MORRIS & INGRAM (LONDON), LTD., 114 Kingston Road, Merton Park, London, S.W.19, inform us that they have acquired all manufacturing and selling rights for the range of engine reconditioning equipment previously made by Newton Bros. (Cudworth), Ltd. The range of machines includes line-borers, connecting rod borers and aligners, valve seat insert tools, pre-setting micrometers, and vee-micrometers.

THE COLEMAN-WALLWORK CO., LTD., Stotfold, Beds., a member of J. Stone & Co. (Holdings), Ltd., have supplied two automatic moulding machines to Russia. These fully-automatic machines, which are pneumatically operated, fill and ram the box, strip the pattern, and eject the mould on to a conveyor ready for coring and closing. Half-moulds up to 3 ft. by 2 ft. by 15 in. deep are produced at the rate of 300 per hour.

FERODO, LTD., Chapel-en-le-Frith, Stockport, have increased their range of sintered metal friction materials by the addition of a bronze-based type known as Ferodo SM7. This material is intended for dry applications only, and is claimed to be particularly suitable for duties where a smooth take-up is required, such as reversing gearboxes for marine drives. It can be supplied sintered either to a metal core, or to a backing plate.

FIRTH CLEVELAND FINANCE, LTD., 8 Cleveland Row, London, S.W.1, a new subsidiary of the Firth Cleveland Group, is concerned with hire purchase transactions for all sections of the motor trade and for industrial plant. The company has recently opened two branch offices, one at County House, 45 East Hill, London, S.W.18, and the other at 15/17 York Street, Sheffield, 1, managed by Mr. P. T. Wilkin and Mr. P. H. Hemmingham, respectively.

FERRANTI, LTD., Hollinwood, Manchester, have received an order from the Belgian Atomic Energy Authority for a Mercury high-speed electronic digital computer. This computer is stated to be the most advanced in speed and scope yet produced in Western Europe, and has already been supplied to six other European atomic centres. The cost of a Mercury computer is £100,000, and of the total of 15 which have been sold to date, five have been exported.

SCHLOEMANN A.G., Dusseldorf, West Germany, are now building double-acting, horizontal, aluminium cable-sheathing presses, for sheaths up to 100 mm. outside diameter. If required, rods, sections, and tubes of pure aluminium can also be produced on these machines. The first sheathing press went into production in the U.S.A. in January, 1957. Similar presses are now being erected in France, Norway, and Germany, and others are under construction.

EXPORTS OF IRON AND STEEL SCRAP.—The Board of Trade, after consultation with the Ministry of Power, announce that they are prepared to consider applications for licences to export to all destinations, other than to ports or countries in the Sino/Soviet Bloc, limited quantities of iron or steel scrap and old metal. Applications stating grade, F.O.B. price, and whether the applicant is in possession of a firm order for the material, should be made to the Export Licensing Branch, Board of Trade, 2-14 Bunhill Row, London, E.C.1, on Form (F).

HARVEY ELECTRONICS, LTD., have formed a new subsidiary, known as Servo Units, Ltd., which will undertake all the parent company's work in the field of servo-mechanisms. In addition to the manufacture of the existing range of Harvey servos, the new company will shortly be producing a series of fully-transistorized power servo units which will operate either from a single D.C. supply or,

alternatively, from A.C. mains current. The address of the new company is 273 Farnborough Road, Farnborough, Hampshire.

TOS-KURIM MILLING MACHINES.—In MACHINERY, 93/77—9/7/5,8 in an article entitled "Some Standard and Special Machine Tools Built in the TOS-Kurim Factory, Czechoslovakia," it was mentioned that the type FA5 vertical, and plain and universal milling machines were demonstrated at the 1956 International Machine Tool Exhibition by the agents, The Selson Machine Tool Co., Ltd., 41-45 Minerva Road, North Acton, London, N.W.10. This company informs us that large numbers of the machines have since been supplied to various users throughout the country.

LONDON TRANSPORT EXECUTIVE have recently opened an apprentice training centre at Acton in order to bring together the instructional facilities provided for those undergoing training at the Acton works. The new building is of single-storey construction, and provides a lecture room, a workshop, locker and wash rooms, and a supervisor's office. Having seating capacity for 30 students, the lecture room is equipped for film and slide projection. Mechanical apprentices will return to the Centre during the fourth year of their training to receive instruction in setting-up capstan lathes, and other advanced work on machine tools.

ENGLISH STEEL CASTINGS CORPORATION, LTD., Sheffield, have recently received an order from the Brush Electrical Co., Ltd., Loughborough, and Beyer, Peacock & Co., Ltd., Manchester, for a substantial quantity of bogie frames required for British Railways 1,250-h.p. main-line diesel-electric locomotives. We may also note that the Grimesthorpe Foundry has recently cast two 168-ton rolling mill housings—said to be the heaviest ever produced in Great Britain—for a 4-high reversing plate roughing mill. This mill, and a finishing mill, are to be built by Davy and United Engineering Company, Limited, Sheffield, for the South Durham Steel & Iron Co., Ltd., Middlesbrough.

SUSPENSION OF DUTY ON IRON AND STEEL PRODUCTS.—Under the Import Duties (Exemptions) (No. 10), (No. 12) and (No. 16) Orders, 1957, the import duties on a wide range of iron and steel products are suspended until September 18, 1958. The suspension of duty on certain cold-reduced sheets and hot-rolled strip has been prolonged until December 31, 1958, by the Import Duties (Exemptions) (No. 8) Order, 1958. After consultation with the Iron and Steel Board about the supply position, Her Majesty's Government have decided that the suspension of duty should not be prolonged beyond September 18, 1958, on the remaining products, with the exception of a particular type of high-carbon steel wire rod.

MASSEY-FERGUSON (GREAT BRITAIN), LTD., are to increase the floor space of their factory at Barton Dock Road, Stretford, Manchester, by a further 100,000 sq. ft. This factory, which was previously enlarged to 300,000 sq. ft. in 1955, now houses 16 lines for the assembly of agricultural implements, and the new extension will be utilized for the storage of finished machines and implements. An additional 10,000 sq. ft. of floor space is to be provided at the company's spares warehouse building at Ashburton Road, Trafford Park, to house the punched-card equipment associated with the material and production control records for the factories at Manchester and Kilmarnock.

## Iron and Steel

(*Continued from page* 398)

393,300 tons in the first half of 1957 and 500,000 in the same period of 1956.

At present, then, there is some surplus capacity for the production of many classes of ferrous materials, so that the consumer is well placed for supplies. It is understood, however, that it has been wisely decided, in general, not to allow this situation to interfere with plans for further modernization and expansion of the iron and steel industry. Even a moderate increase in the level of industrial activity could have the effect of speedily reversing the position, and in the meanwhile special efforts must be made to retain and expand export markets in the face of the greater competition that it necessarily being encountered.

## Correction

In MACHINERY, 93/390—13/8/58 the name of the recipient of a gold medal awarded in connection with the Seventh International Exhibition of Inventions was given incorrectly. This award, for a pressurized assembly cabinet, was made to Mr. John Bass, and the title of the company is John Bass, Ltd.

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20/8/58

## Moog Valve Licence Agreement

Dowty Equipment, Ltd., Arle Court, Cheltenham, Glos., announce that they have concluded exclusive licensing arrangements with the Moog Valve Co., Inc., East Aurora, New York, U.S.A., whereby Moog servo valves, which are extensively used in U.S.A. on aircraft, guided missiles and industrial equipment, will be manufactured in this country. The licence agreement covers the United Kingdom, British Commonwealth (excluding Canada) and Europe (excluding Iron Curtain countries).

Moog valves are of the closed-centre, 4-way spool type, and the hydraulic output is proportional to the electric input. Advantages claimed include high dynamic performance, compactness, low weight, and high sensitivity. It is stated that the American company has supplied more than 50,000 valves in the past eight years.

## Personal

MR. W. WHITTAKER has been appointed to the board of Claude Rye Bearings, 895/921 Fulham Road, London, S.W.6. He has been technical manager of the company for the past three years.

MR. W. ERNEST BRADLEY and MR. RONALD MOUNTAIN have been appointed sales engineers at the Huddersfield and London offices, respectively, of Brook Motors, Ltd., Empress Works, Huddersfield.

MR. H. H. SAINT has been appointed general sales manager, responsible for home sales, of Fawcett Preston & Co., Ltd., Dock Road, Bromborough, Cheshire, a member of the Metal Industries Group. MR. E. P. BRIDSON, who was formerly responsible for the company's London office, has been appointed export sales manager.

MISS DOROTHY SMITH has been elected to full membership of the Institution of Electrical Engineers, and is the first woman to be accorded this distinction since 1899. Miss Smith is a member of the electrical engineering department of Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, and was engaged in the development of the company's R-type induction motor.

MR. RALPH GABRIEL has been appointed managing director of Charles Churchill & Co., Ltd., Coventry Road, South Yardley, Birmingham, the parent company of the Charles Churchill group. Educated at Mill Hill and Emmanuel College, Cambridge, Mr. Gabriel obtained an M.A. degree in engineering. During the war he was commissioned in the Royal Electrical and Mechanical Engineers, and served in Europe and the Middle East. For a short time he worked with Cincinnati Milling Machines, Ltd., in Birmingham, and from 1948 to 1950 with the parent company in the U.S.A.

Mr. R. Gabriel

Mr. Gabriel returned to this country in 1950 and joined the Scotswood Division of Churchill Redman, Ltd., at Newcastle. He was later appointed a director of Churchill-Redman, a post which he continued to hold when he joined the parent company of the Group in Birmingham in June, 1955. He was appointed a director of the parent company in 1957, and took over the duties of assistant managing director in August of that year.

MR. W. H. EVERARD, manager of the electric furnaces, tropenas and heat treatment departments of Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield, has been appointed secretary of the Electric Steelmakers' Guild. The guild was formed last year to promote progress in the manufacture of steel for commercial purposes in electric melting furnaces, and to encourage exchange of information between members.

## Scrap Metals

†LONDON.—‡Prices per ton for non-ferrous scrap metals free from iron are as follows:—clean copper wire, untinned and free from lead and solder, £160; clean heavy copper, untinned and free from lead and solder, £154; copper, wire, No. 2, £147; clean light copper, £142; braziery copper, £126; gunmetal, £129; brass, mixed, £92; lead, net, £56; zinc, £29; cast aluminium, £84; old rolled aluminium, £107; battery lead, £29; unsweated brass radiators, £78; hollow pewter, £495; black pewter, £365.

MIDLANDS.—The trading position in the Midlands shows no immediate prospects of improvement. Following the annual holidays it was hoped that deliveries to steelworks and foundries would begin immediately if only on a restricted basis, but few if any allocations were made until August 18.

The prospects of licences being granted for export of scrap has resulted in some activity and provided that prices are reasonable and the necessary permission is given, deliveries will begin shortly.

As from November 1, the Control Order will cease to be operative and prices will find their own level, as has happened recently in connection with certain grades of scrap for blast furnace use.

Only scrap produced by manufacturing firms is being moved regularly, and as most of this material is going into stock at merchants' yards, prices are falling steadily. It is difficult to move any foundry scrap and large quantities of cast iron and short steel scrap are accumulating in the Midlands, for which no offers can be made.

Current maximum control prices, delivered consumers' works, are now: *Heavy steel No. 1, 217s. 6d.; *heavy steel No. 2, 196s.; *heavy steel No. 4, 207s. 6d.; *heavy steel No. 5, 195s. 6d.; light iron No. 8, 149s.; short turnings No. 9 (free from alloy), 167s. 3d.; light steel No. 11, 164s. 3d.; bushy turnings, 117s.; short alloy turnings, 160s. 9d.; short steel No. 2, 233s. 3d.; machinery cast, 233s.

Prices may be increased up to 2s. 6d. per ton according to quantities tendered over a given period.

* For use by Round Oak Steelworks, Brierley Hill, increase by 1s. 6d. per ton.
† George Cohen, Sons & Co., Ltd., 600 Commercial Road, E.14.
‡ Subject to market fluctuations.

## Machine Tool Share Market

Stock markets were generally firm during the period under review, with business in most sections on a fairly good scale, and price movements mainly to higher levels.

The gilt-edged market met with moderate support, and quotations for British Funds and similar issues steadily appreciated and finished at the highest levels.

Commercial and industrial share markets displayed a bright tendency. There was an upward trend on account of selective demand and restricted market supplies of stock, and gains on balance were numerous and well spread.

Among machine tool issues, Arnott & Harrison advanced 3d. to 13s. 9d.; Butler Machine Tools, 3d. to 6s. 6d.; Geo. Cohen, 3d. to 11s. 6d.; Ambrose Shardlow, 3d. to 37s.; Sheffield Twist Drill, 3d. to 11s. 6d.; Asquith Machine Tool, 9d. to 19s. 6d.; Birmingham Small Arms, 6d. to 30s.; Clarkson Engineers, 6d. to 13s. 6d.; John Harper, 6d. to 13s. 6d.; and British Oxygen, 1s. to 38s. On the other hand, Brooke Tool lost 1½d. at 4s. 7½d.; Coventry Gauge & Tool, 1½d. at 14s. 1½d.; John Shaw & Sons (Wolverhampton), 1½d. at 12s. 6d.; Kayser Ellison, 1s. at 45s.; and Thos. W. Ward, 1s. at 77s.

ALFRED HERBERT, LTD. Interim dividend, 2 per cent (tax free).

TAP & DIE CORPORATION, LTD. Final dividend 6 per cent, making, with the interim, a total distribution of 12 per cent for the year to May 31. A first interim of 4 per cent has also been declared in respect of 1958-59.

## Books Received

THE BRITISH ENGINEERS' HANDBOOK, 1958. The British Engineers' Association (Inc.), 32 Victoria Street, London, S.W.1. 660 pp. [Price 21s.]

The 29th edition of this annual classified handbook contains a list of the members of the Association and their products, also trade marks and trade names, and is indexed in Portugese, French, German, and Spanish.

THE COAL INDUSTRY OF THE U.S.S.R., PART 2.—SPECIAL MINING TECHNIQUES. The National Coal Board, — 43 pp. [Price 3s.]

This sixth and concluding volume of the second part of the report compiled by the Technical Mission of the National Coal Board on the coal industry of the U.S.S.R. is divided into three main sections, concerned with hydraulic mining, hydraulic winning with pulsed infusion shot-firing, and flexible sectionless shield support working. The information presented is based on three papers published by Ugletekhizdat, Moscow, and the text is accompanied by numerous line drawings.

| COMPANY | | Denom. | Middle Price |
|---|---|---|---|
| Akwood Machine Tools, Ltd. | Ord. | 1/– | 9d.xd |
| Armstrongs, Stevens & Son, Ltd. | Ord. | 5/– | 8/3 |
| Allen (Edgar) & Co., Ltd. | Ord. | £1 | 32/– |
| " " | 5% Prf. | £1 | 14 6* |
| Arnott & Harrison, Ltd. | Ord. | 4/– | 13 9 |
| Asquith Machine Tools Corp., Ltd. | Ord. | 5/– | 19 6 |
| " " " | 6% Cum. Prf. | £1 | 18 6 |
| Birmingham Small Arms Co., Ltd. | Ord. | £1 | 30/– |
| " " " | 5% Cum. "A" Prf. | £1 | 15 6 |
| " " " | 6% Cum. "B" Prf. | £1 | 17 6 |
| " " " | 4% 1st Mort. Deb. | Stk. | 86/– |
| British Oxygen Co., Ltd. | Ord. | £1 | 38/-xd |
| " " | 6¼% Cum. Prf. | £1 | 21 3 |
| Brooke Tool Manufacturing Co., Ltd. | Ord. | 5/– | 4 7½xd |
| Broom & Wade, Ltd. | Ord. | 5/– | 11 6 |
| " " | 6% Cum. Prf. | £1 | 17 9 |
| Brown (David) Corporation Ltd. | 5¼% Cum. Prf. | £1 | 14/– |
| Buck & Hickman, Ltd. | 6% Cum. Prf. | £1 | 17 9 |
| Butler Machine Tools Co., Ltd. | Ord. | 5/– | 6 6 |
| " " | 5% Cum. Prf. | £1 | 13 9 |
| C.V.A. Jigs, Moulds & Tools, Ltd. | 5½% Red. Cum. Prf. | £1 | 13 9 |
| Churchill (Charles) & Co., Ltd. | Ord. | 2/– | 4 10½ |
| " " | 6% Cum. Prf. | £1 | 26 3 |
| Churchill Machine Tool Co., Ltd. | Ord. | 5/– | 17 9 |
| " " | 6% Cum. Prf. | £1 | 18 6 |
| Clerkson (Engrs.), Ltd. | Ord. | 5/– | 13 6 |
| Cohen (George), Son & Co., Ltd. | Ord. | 5/– | 11 6 |
| " " | 4½% Cum. Prf. | £1 | 14 6 |
| Coventry Gauge & Tool Co., Ltd. | Ord. | 10/– | 14 1½xd |
| " " " | 5% Cum. Red. Prf. | £1 | 16 3 |
| Coventry Machine Tool Works, Ltd. | Ord. | 4/– | 8 3 |
| Craven Bros. (Manchester), Ltd. | Ord. | 5/– | 6 7½ |
| Elliott (B.) & Co., Ltd. | Ord. | 1/– | 2 9 |
| " " | 4½% Red. Cum. Prf. | £1 | 13 9 |
| Export Tool & Case Hardening Co., Ltd. | Ord. | 2/– | 1 3 |
| Firth Brown Tools, Ltd. | 4% Cum. Prf. | £1 | 12/– |
| Greenwood & Batley, Ltd. | Ord. | £1 | 48 1½ |
| Harper (John) & Co., Ltd. | Ord. | 5/– | 13/6 |
| " " | 4½% Red. Cum. Prf. | £1 | 13 1½ |
| Herbert (Alfred), Ltd. | Ord. | £1 | 35/– |
| Holroyd (John) & Co., Ltd. | "A" Ord. | 5/– | 10/6 |
| " " | "B" Ord. | 5/– | 10 3 |
| Jones (A. A.) & Shipman, Ltd. | Ord. | 5/– | 21 3 |
| " " | 7% Cum. Prf. | 5/– | 5/– |
| Keyser, Ellison & Co., Ltd. | Ord. | £1 | 45/– |
| " " " | 6% Cum. Prf. | £1 | 18 3 |
| Kendall & Gent, Ltd. | Ord. | 5/– | 7 7½ |
| Kerry's (Gt. Britain), Ltd. | Ord. | 5/– | 6 3 |
| Kitchen & Wade, Ltd. | Ord. | 4/– | 8/6 ex rights 2 4½ |
| Martin Bros. (Machinery), Ltd. | Ord. | 2/– | 8 3 |
| Massey, B. & S., Ltd. | Ord. | 5/– | 10 7½ |
| Modern Engineering Machine Tools Ltd. | Ord. | 5/– | 4/9 |
| Newall Engineering Co., Ltd. | Ord. | 2/– | 2 3 |
| Newman Industries, Ltd. | Ord. | 2/– | 5 6 |
| " " | 6% Prf. Ord. | 5/– | 2 9xd |
| Noble & Lund, Ltd. | Ord. | 2/– | 18 3 |
| Osborn (Samuel) & Co., Ltd. | Ord. | 5/– | 25 9 |
| " " " | 5½% Cum. Prf. | £1 | 21 3 |
| Pratt (F.) & Co., Ltd. | Ord. | 5/– | 5/– |
| Scottish Machine Tool Corporation, Ltd. | Ord. | 4/– | 37/– |
| Shardlow (Ambrose) & Co., Ltd. | Ord. | £1 | 12 6 |
| Shaw (John) & Sons, Wolverhampton, Ltd. | Ord. | 5/– | 11 6 |
| Sheffield Twist Drill & Steel Co., Ltd. | Ord. | 4/– | 15/– |
| " " " " | 5% Cum. Prf. | £1 | 6 3 |
| Stedall & Co., Ltd. | Ord. | 5/– | 8/– |
| Tap & Die Corporation, Ltd. | Ord. | 5/– | 82/– |
| " " " | 4½% Deb. 1961-1977 | Stk. | 17 6 |
| Wadkin, Ltd. | Ord. | 10/– | 77/– |
| Ward (Thos.) W., Ltd. | Ord. | £1 | 15 9 |
| " " | 5% Cum. 1st Prf. | £1 | 24/– |
| " " | 5% Cum. 2nd Prf. | £1 | 2 4½ |
| Willson Lathes, Ltd. | Ord. | 1/– | |

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

# PRICES OF MATERIALS

All prices per ton except where otherwise stated.

## Pig-Iron

### Foundry and Forge No. 3, Class 2

| | |
|---|---|
| Middlesbrough zone | £21 6 0 |
| Birmingham | £20 18 3 |

### Phos. 0·1 to 0·75%

| | |
|---|---|
| Birmingham | £23 17 0 |

### Scottish Foundry

| | |
|---|---|
| Grangemouth | £25 3 6 |

### Hæmatite

### English No. 1

| | |
|---|---|
| N.E. and N.W. Coast | £25 6 6 |
| Scotland | £25 13 0 |
| Sheffield | £26 15 0 |
| Birmingham | £27 4 0 |

### Welsh

£25 6 6

## Steel Products

| | |
|---|---|
| Medium plates | £45 11 6 |
| Mild steel plates, ordinary* | £42 2 0 |
| Boiler plates* | £44 12 0 |
| †Flat bars 5 in. wide and under<br>†Round bars under 3 in. | £40 0 6 |
| Billets, rolling quality, soft U.T. | £32 15 6 |

## Phosphor Bronze

| | |
|---|---|
| Ingots (2B8) (A.I.D.) d/d | £255 0 0 |

## Copper

| | |
|---|---|
| Cash (mean) | £207 15 0 |
| Cold rolled and hot rolled sheets 4 ft. by 2 ft. by 10 SWG | £273 15s. 0—£274 0 0 |
| Rods ⅞ in. to 4 in. diam. | £291 15 0 |
| Tubes, 1½ in. bore by 10 SWG, ton lots, per lb. | 2s. 9½d. |
| Wire rod, black, hot-rolled (½–⅞ in.) English | £222 2 6 |

## Zinc

| | |
|---|---|
| Refined, minimum 98 per cent. purity, current month (mean) | £63 17 6 |

## Brass

| | |
|---|---|
| Tubes, solid drawn, per lb. | 1s. 7½d. |
| Strip 63/37, 6 in. by 10 SWG coils, ton lots | £229 10 0—£232 0 0 |
| Rods, ½–3 in. diam. (59 per cent copper) | 1s. 9½d. |

## Yellow Metal

| | |
|---|---|
| Condenser plates, per ton | £166 0 0 |
| Rods, per lb. | 1s. 10½d. |

## Aluminium

| | |
|---|---|
| Ingots min. 99·5 per cent Canadian d/d | £180 0 0 |

## Lead

| | |
|---|---|
| Refined, minimum 99·97 per cent purity, current month (mean) | £69 17 6 |

## Tinplates

| | |
|---|---|
| ‡U.K. Home trade: | |
| Handmill f.o.t. makers' works | £3 11 8½ |
| Cold reduced, f.o.t. makers' works | £3 7 4½ |
| U.K. Export: | |
| Hot rolled basis, f.o.t. works' port | 72s. 6d.—75s. 0d. |
| Cold reduced basis, f.o.t. works' port | 75s. 0d. |

## Gunmetal

| | |
|---|---|
| Ingots, 85.5.5.5. ex works | £172 0 0 |

* N.E. Coast, N. Joint Area, Central Scottish Zone.
† U.T. soft basic.
‡ Official maximum price, after allowing for adjustments for increase in price of tin.

## MAKERS' PRICES

### Hexagon Steel Bars[1]

| | |
|---|---|
| Sizes in inches from 1 in. up to 2·21 and 2·41 a/f, ex works 2 ton basis | £42 17 0 |
| Free cutting black | £47 6 6 |

### Reeled Steel Bars[1]

| | |
|---|---|
| Single-reeled 1½ in. upwards, f.o.t. works (+ usual extra for sizes) | £43 9 6 |
| Free cutting | £47 19 0 |

### High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

| | |
|---|---|
| Molybdenum "66" | 5s. 10½d. |
| Molybdenum "46" | 5s. 8½d. |
| 14 per cent tungsten | 5s. 9d. |
| 16 per cent tungsten | 6s. 1½d. |
| 18 per cent tungsten | 6s. 4d. |
| 22 per cent tungsten | 7s. 5d. |
| 5 per cent cobalt | 9s. 6d. |
| 4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2) | 6s. 0½d. |

### Precision-ground, High-speed Free-turning Brass Rod[2]

| | |
|---|---|
| ½-in. dia. ± 0·00025-in. 2-ton lots, per lb. | 2s. 5½d. |

### Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 26 in. rough machined ⅛-in. above listed size. Extra for definite lengths. Discounts for orders over £150.

| | Per cwt. net. Mark I | Mark III |
|---|---|---|
| ¼ or ⅜ in. | 245s. 4d. | 318s. 10d. |
| ½ or ¾ in. | 196s. 4d. | 251s. 10d. |
| 1 or 1¼ in. | 137s. 10d. | 171s. 2d. |
| 1½ to 1¾ in. | 106s. 2d. | 125s. 11d. |
| 1⅞ to 2 in. | 91s. 6d. | 106s. 4d. |
| 2⅛ to 3½ in. | 86s. 6d. | 99s. 2d. |
| 3⅝ to 12 in | | |

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

| | | |
|---|---|---|
| 6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4] Per cwt. net | ¼ or ⅜ in. | 245s. 4d. |
| | ½ or ¾ in. | 196s. 4d. |
| | 1½ to 1¾ in. | 137s. 10d. |
| | 1⅞ to 2 in. | 106s. 2d. |
| | 2⅛ to 3½ in. | 91s. 6d. |

### Stellite[5]

Welding Rods plain

| | |
|---|---|
| ½ in. dia. per lb. | 30s. 0d. |

Toolbits

| | |
|---|---|
| ½ in. sq. × 4 in., each | 22s 3d. |

### Precision-ground Mild Steel[2]

| | |
|---|---|
| * 1-in. dia. + 0·00025-in. 4-ton lots, per cwt. | 121s. 6d. |

1 Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. 2 Pratt, Levick & Co., Ltd., Chester. 3 Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. 4 "Flocast," Harold Andrews Sheepbridge, Ltd., Halesowen. 5 Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

## BASIC PRICES FROM LONDON STOCK[6]

### Free Cutting Steel

| | |
|---|---|
| Bright cold drawn: | |
| (Usaspead) over 1½ to 2 in. | £59 17 6 |
| Lead bearing (Usaled) | £64 4 0 |
| Precision ground, 1⅛ in. | £81 12 6 |

### Bright Drawn

| | |
|---|---|
| M.S. bars (M.M.C.) over 1½ in. to 2 in. | £55 3 6 |
| Square edge flats (Usaflat) | £72 0 0 |
| M.S. angles (Usaspead) | £99 10 0 |
| Casehardening (EN) (Usacase) over 1½ in. to 2 in. | £63 9 6 |
| M.S. bars (EN3B) (Usamild) over 1½ to 2 in. | £57 3 6 |
| Carbon manganese semi-freecutting case hardening (EN202) (Usaspead 202) over 1½ to 2 in. | £72 19 0 |
| 35/45 ton tensile (EN6) (Usen) over 1 to 1½ in. | £64 17 6 |
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| Carbon manganese steel to Specification EN.16.T (Usaspead 5565), per ton | £127 11 3 |

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18-, 24-, and 36-in. lengths (Usaspead). List prices less 5 per cent

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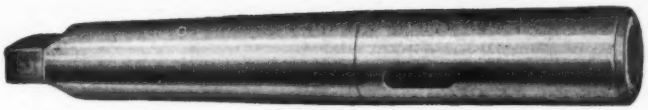

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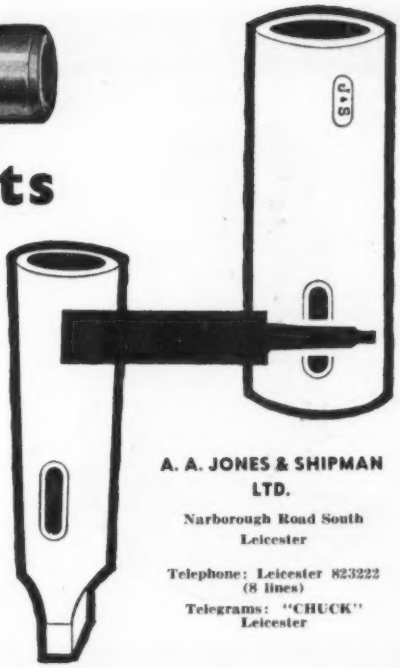


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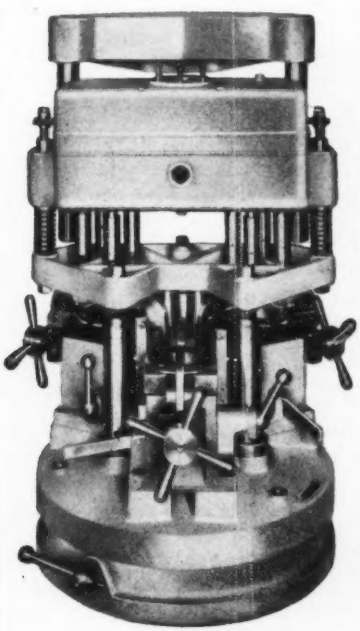

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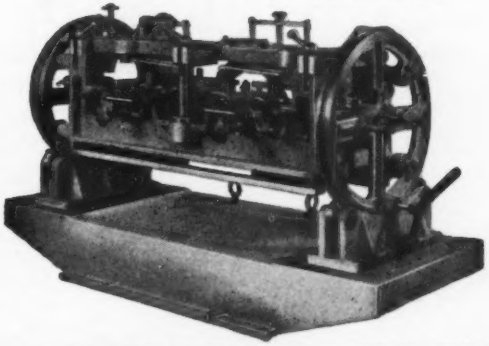

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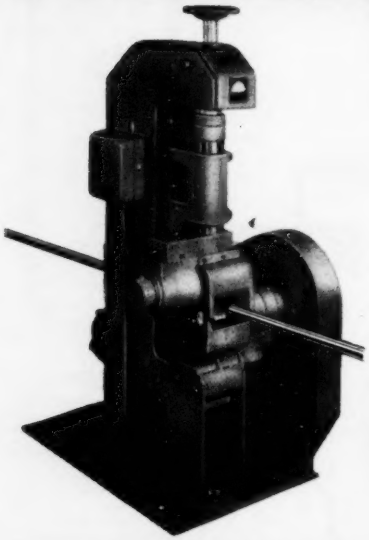

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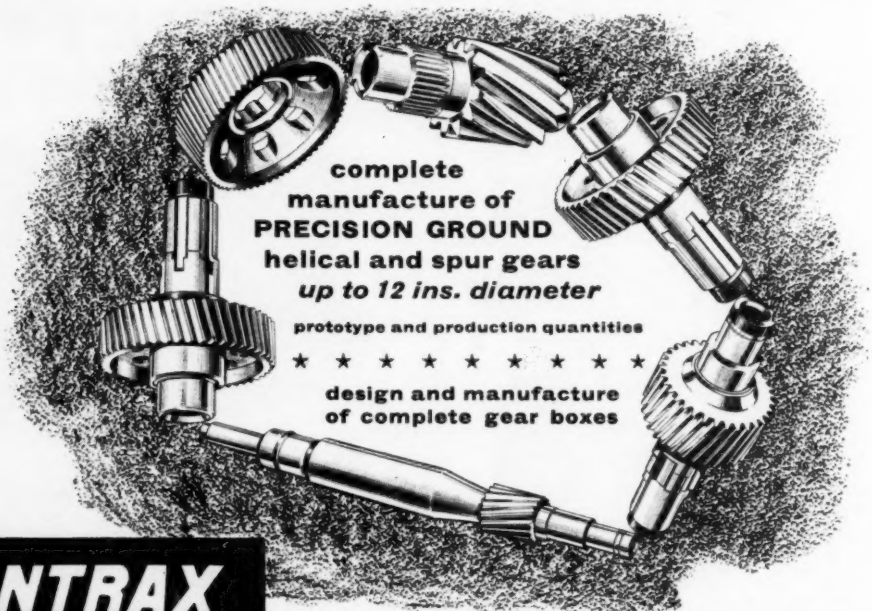


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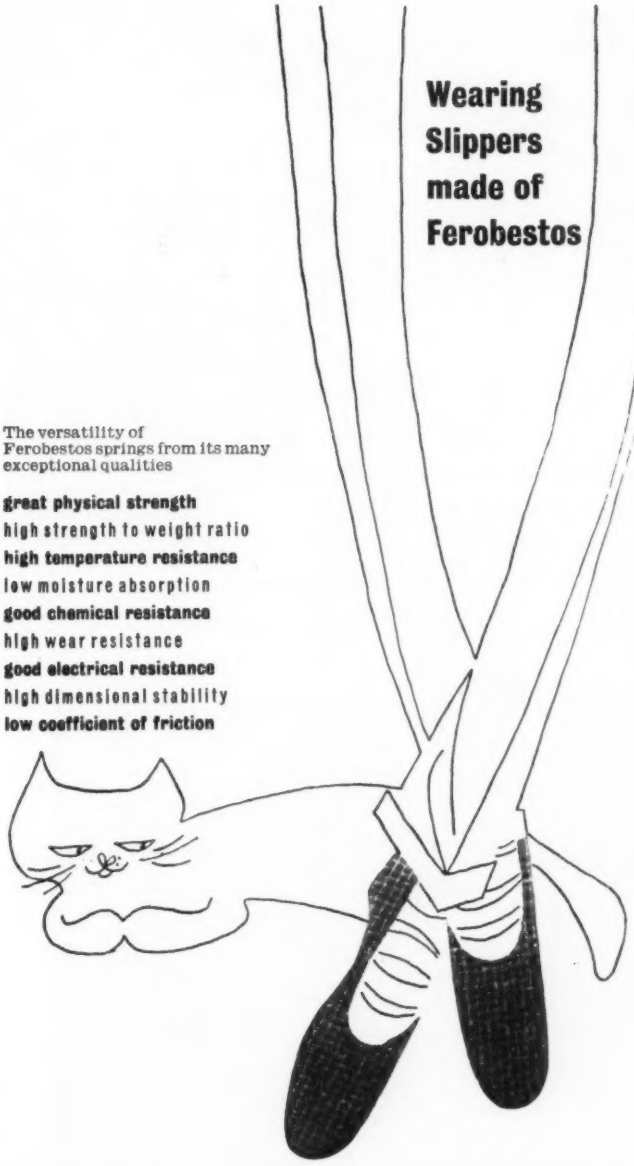

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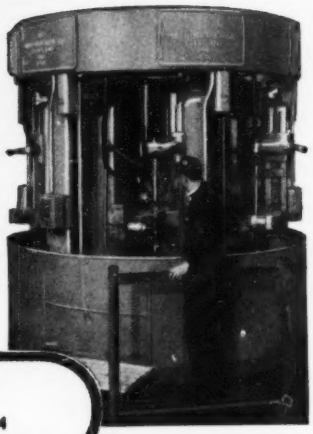

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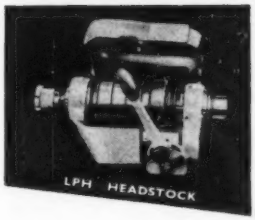

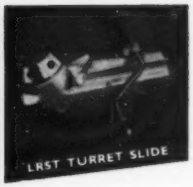

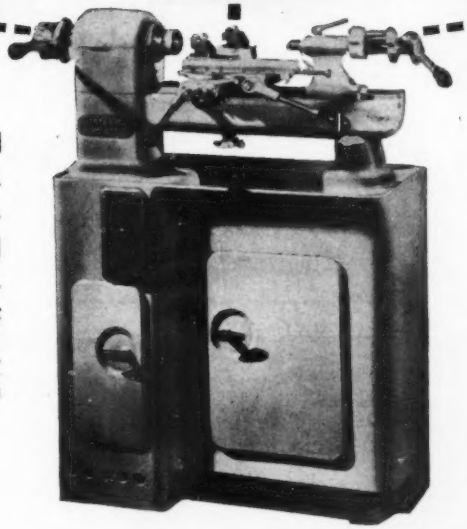

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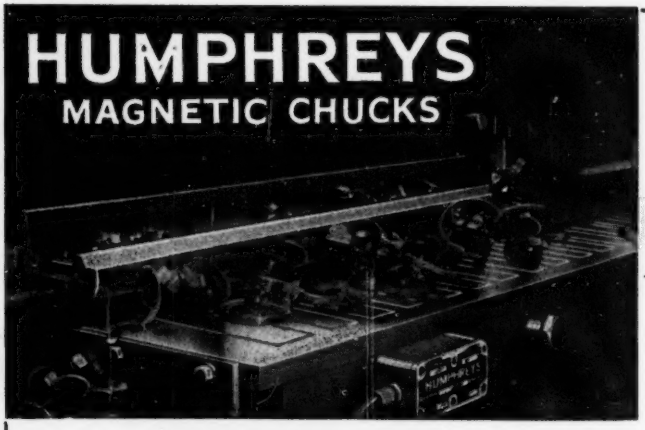

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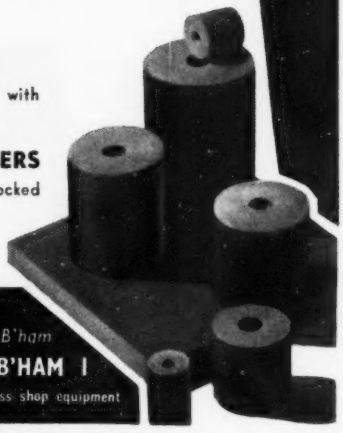

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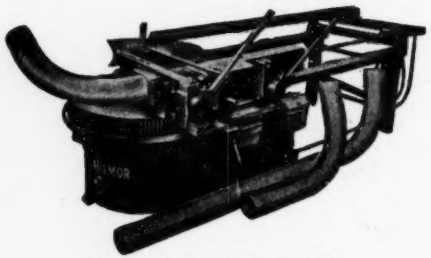

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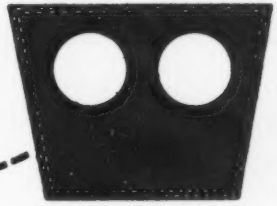

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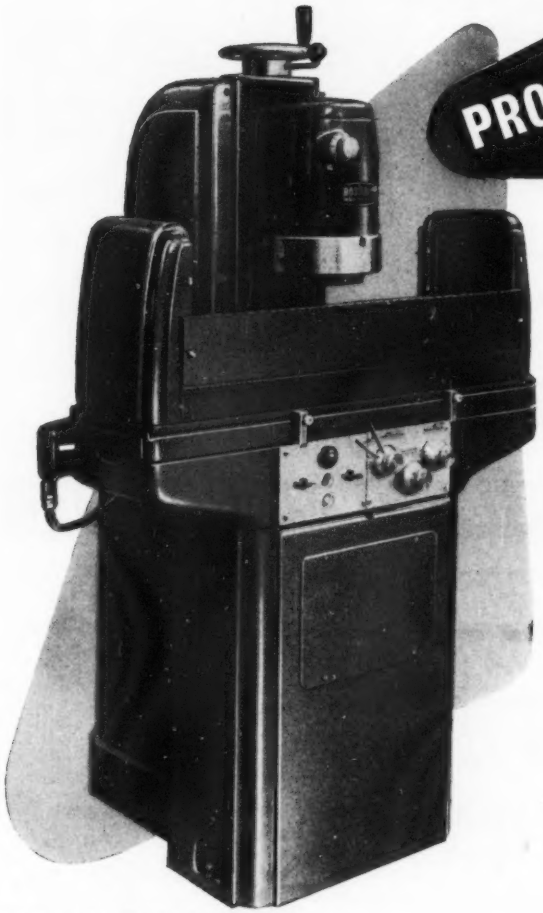

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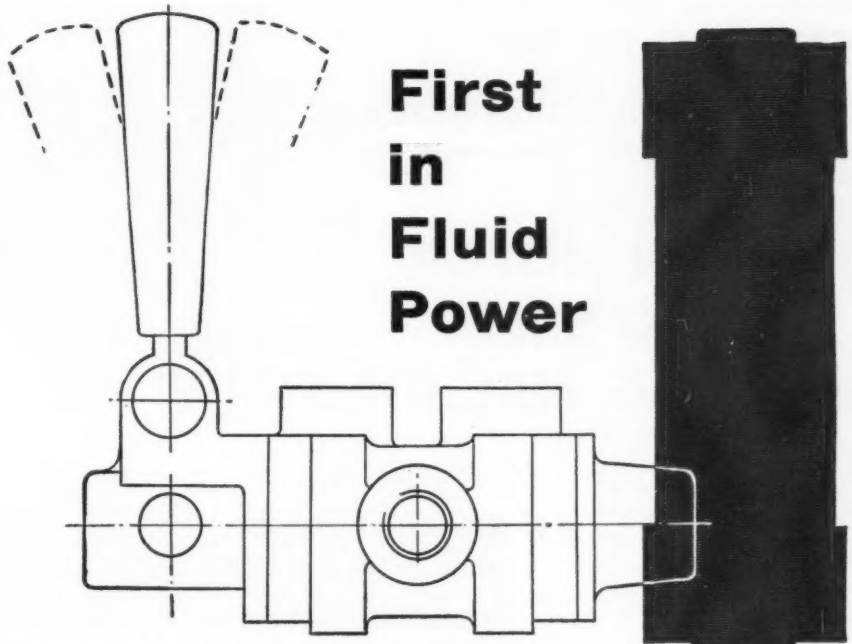

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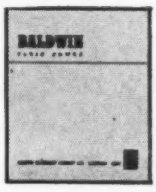


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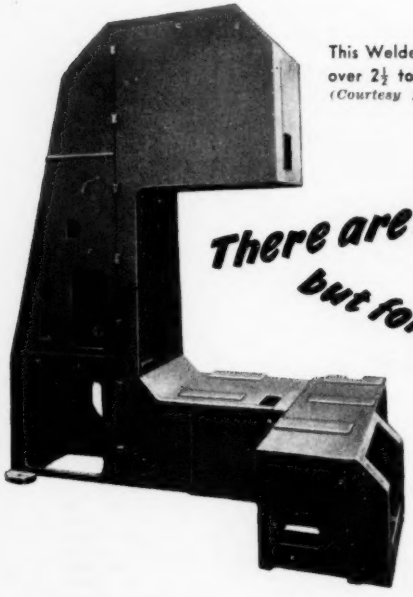

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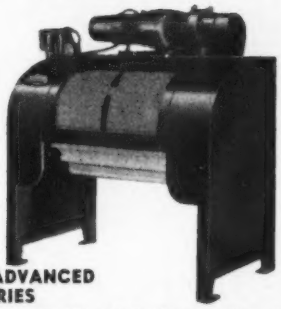
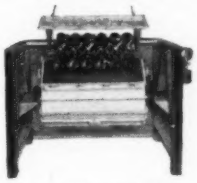


Model DB 200

**ALMCO'S "ADVANCED DESIGN" SERIES**

Thirteen great models in this series! These machines feature a wide range of variable speeds (infinite from 6 to 30 r.p.m.), making possible economical deburring and finishing of the greatest variety of parts. Each unit has Almco's exclusive design features and rugged construction to stand up under all types of punishing applications.

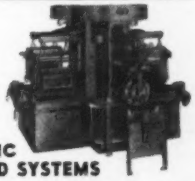


**"FIXTURE" TYPE BARRELS**

Pioneered by Almco for processing large and intricate parts. Custom designed fixtures hold parts securely, prevent part-on-part impingement and allow abrasive action to reach all surfaces, cavities, slots, etc. Barrels have automatic forward and reverse controls.

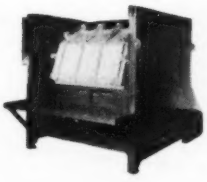
**MULTI-COMPARTMENT BARRELS**

Do you have these deburring and finishing problems—wide variety of parts or small quantity runs where fixtures would be too costly? Lack of floor space for several machines? An Almco custom-designed multi-compartment barrel may give you a cost-saving answer. Automatic forward and reverse. Any combination of compartments and doors.



**SUB-O-MATIC AUTOMATED SYSTEMS**

Almco's exclusive submerged unit is an automatic, "assembly line" system for micro-precision deburring and finishing of small parts in quantity. Saves labour, speeds up processing and flow of high production parts. One man can operate this equipment and handle as many as 192 barrel loads per 16 hr. day. Slashes compound expense to minimum. These submerged systems can also be obtained in non-automated, straight line systems.



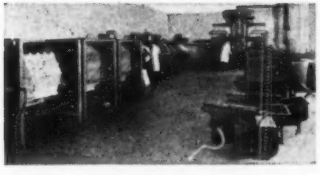
**CUSTOM-DESIGNED BARRELS**

Almco designs and manufactures special barrels of all types for problems where standard equipment cannot be effectively used. These range from the smallest type to the largest fixture barrel such as the 60" diameter x 60" length barrel shown above. Special large diameter barrels with double flat or triple flat doors are also available to accommodate extra large parts and to allow abrasive media to flow freely over the outer periphery of the part. Your special problems may be solved with one of Almco's custom-designed barrels.

Model DB 01A

**SMALLER MACHINES**

Twin barrel machines manufactured by Almco are the standard of the industry for processing small lots of parts and for companies with large lots of small parts. Also ideal for sample processing, barrel finishing research and development work. These units are Almco engineered to the highest specification standards and include operational and safety features found on larger Almco machines.



YOUR SAMPLE PARTS PROCESSED without obligation in modern Almco test labs. Simply send parts direct to Hitchin, Herts. Enclose specifications desired. Complete free report includes recommendation.

Almco deburring and finishing machines are ruggedly constructed to perform on a round-the-clock basis. They incorporate the best engineering design required in the industry—your assurance of versatility and economical processing of work parts. Optional equipment includes material handling devices and systems, automatic forward and reverse, double or triple flat doors, single and dual timer controls for automatic delay starting and stopping, perforated drain doors for flushing and rinsing unloading devices, etc. Also a full and complete line of Almco Supersheen barrel finishing compounds and media of all types made especially for use with Almco precision barrel finishing equipment.

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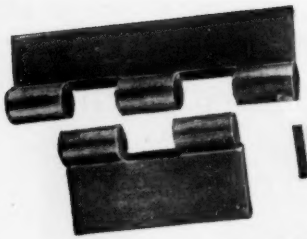

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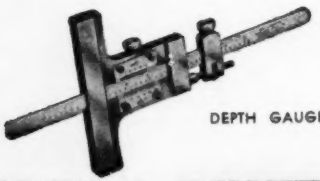


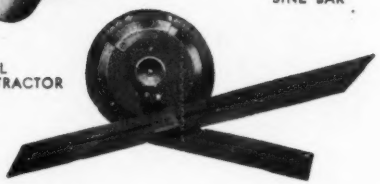


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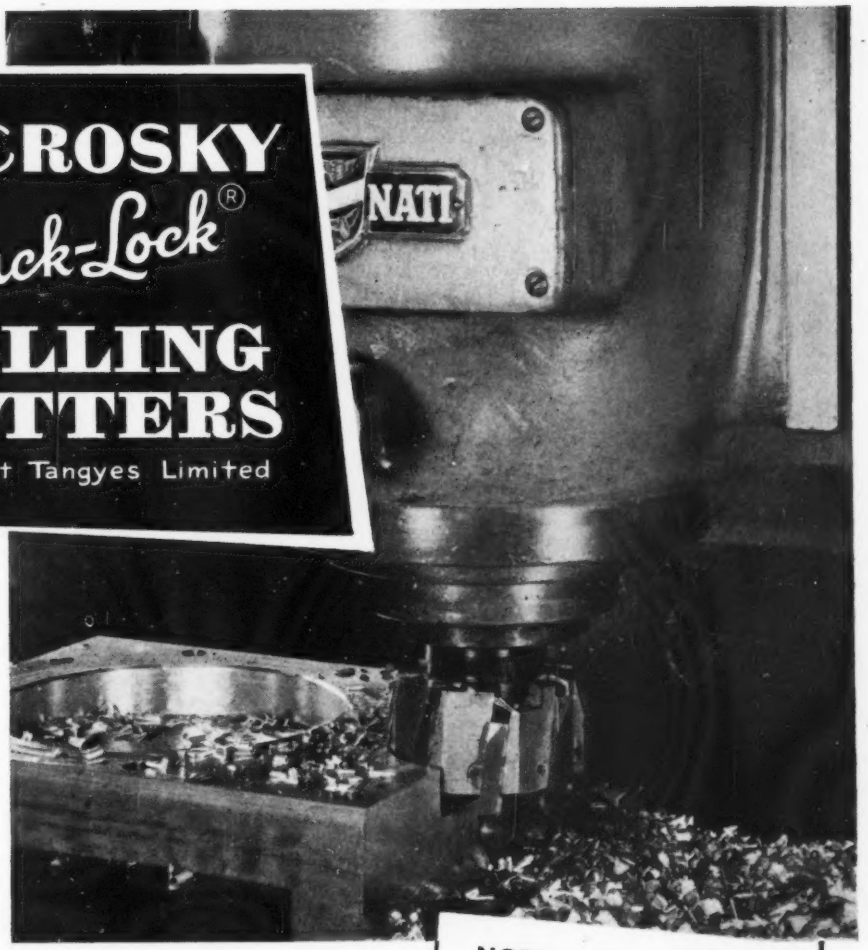

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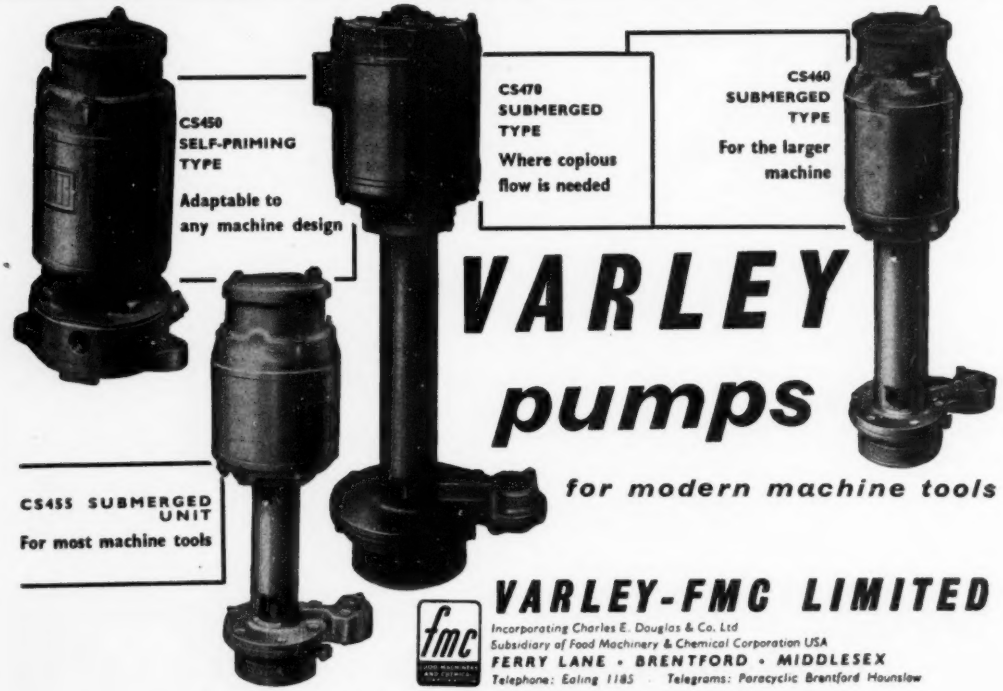


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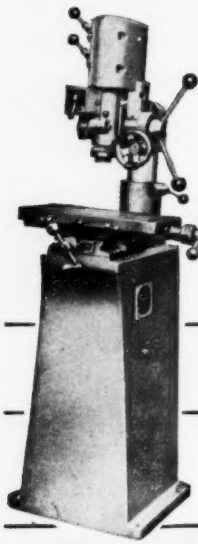

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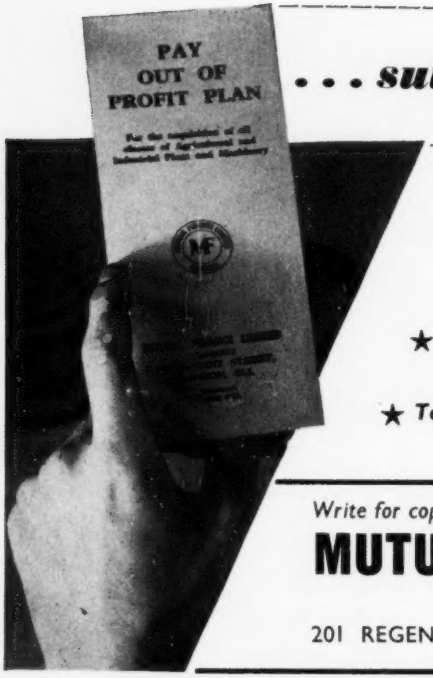


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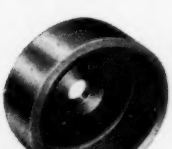

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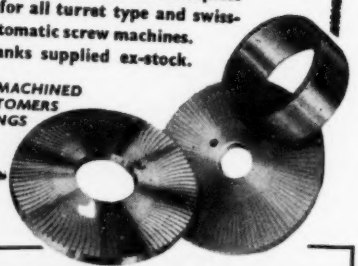

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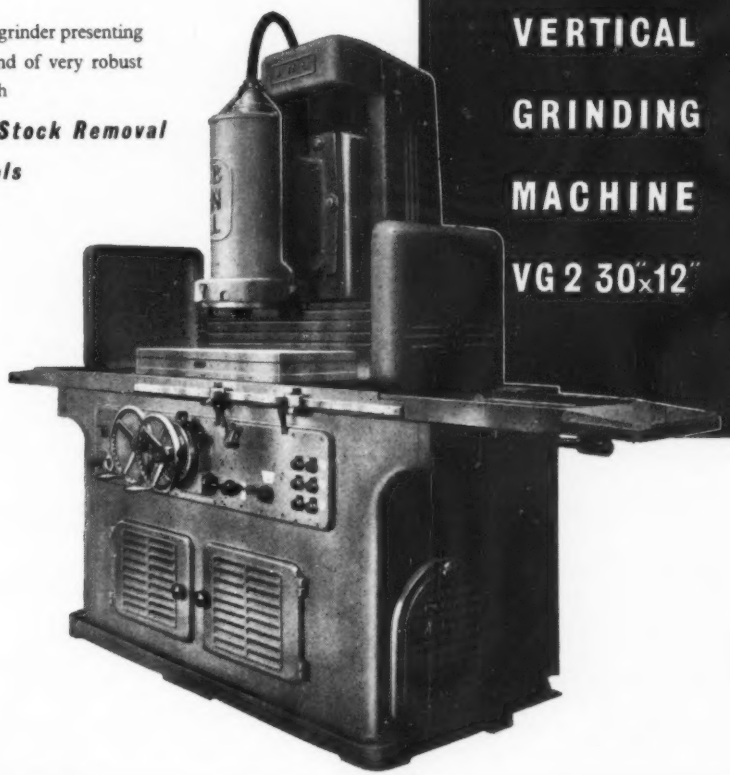

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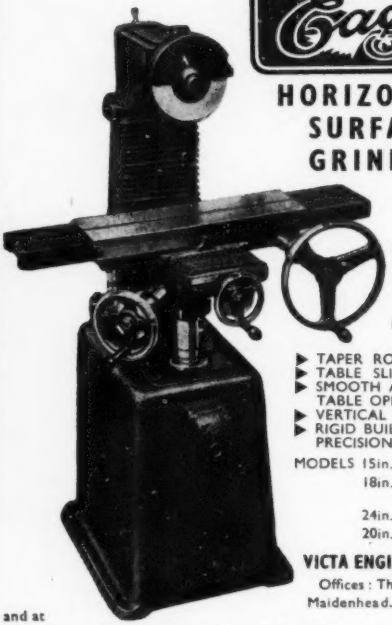

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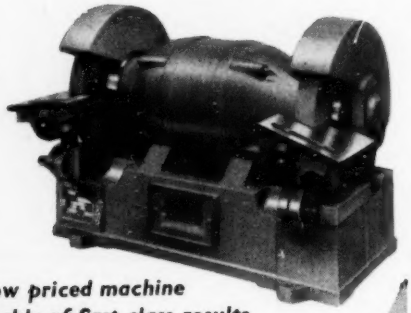

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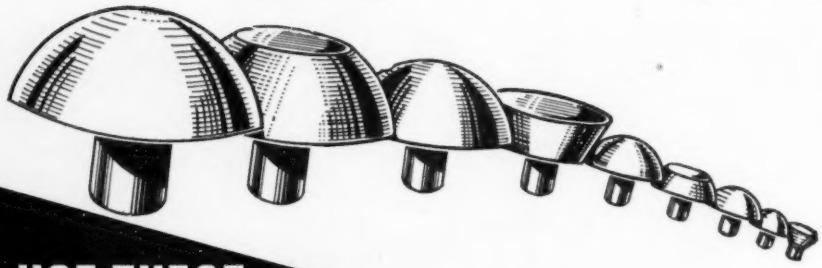

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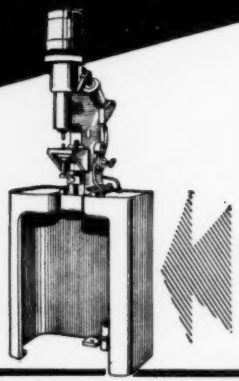

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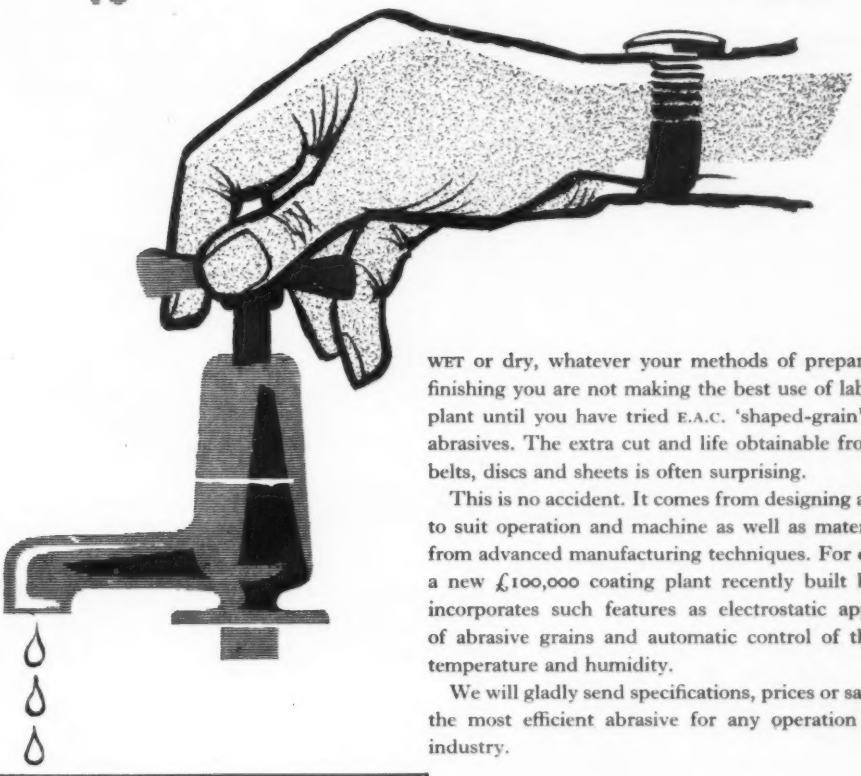

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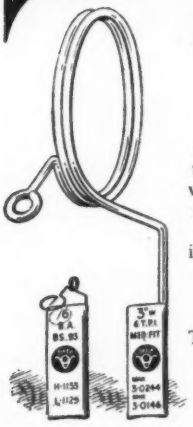

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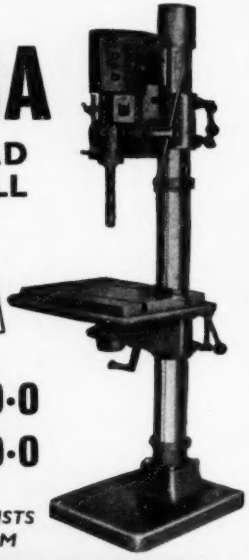

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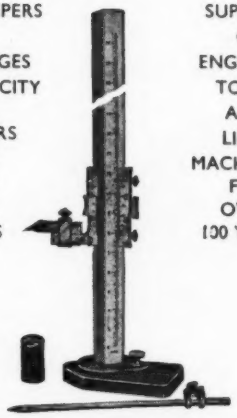

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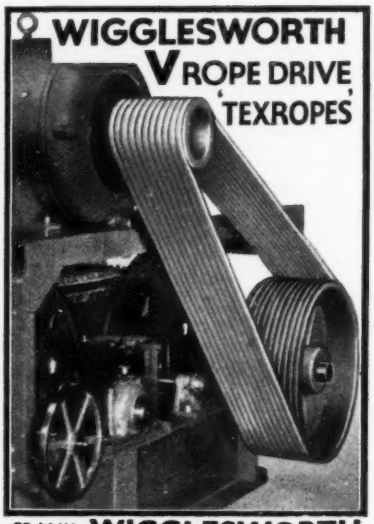

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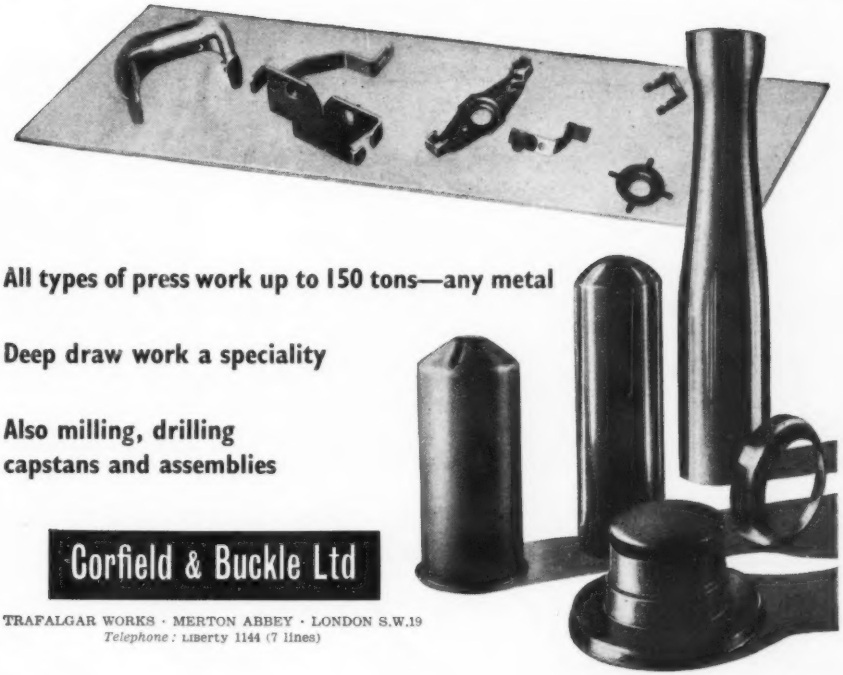

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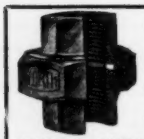

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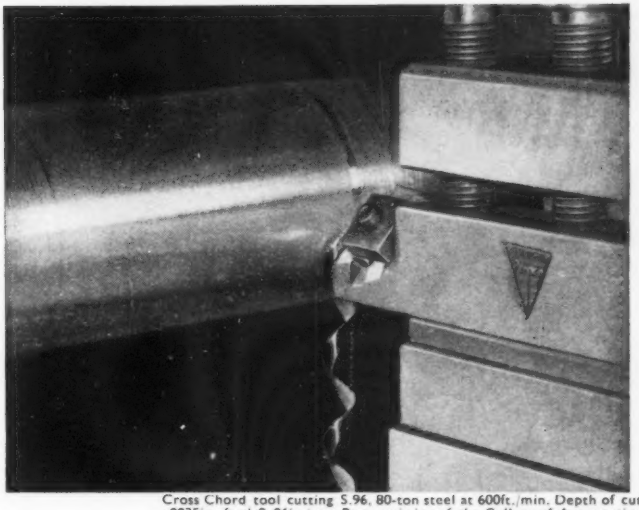

Cross Chord tool cutting S.96, 80-ton steel at 600ft./min. Depth of cut ·0035in., feed 0·06in./rev. By permission of the College of Aeronautics.

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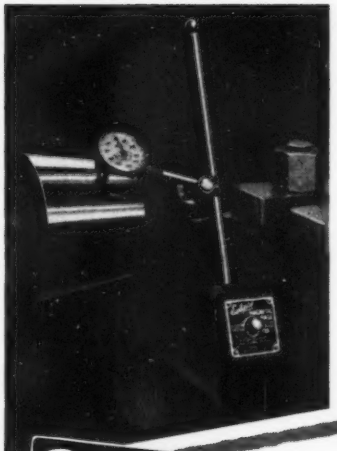

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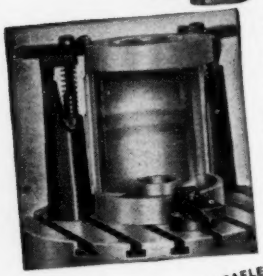

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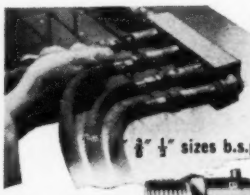

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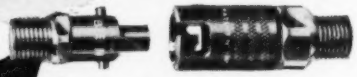

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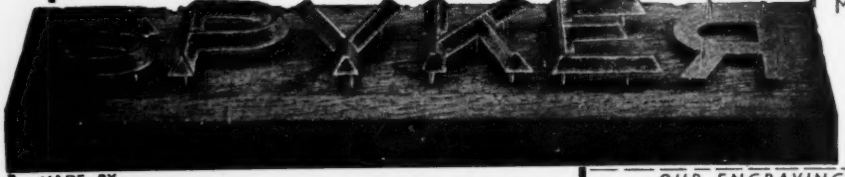


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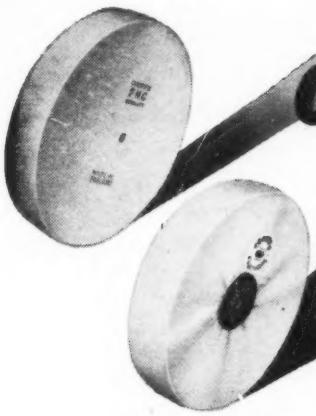

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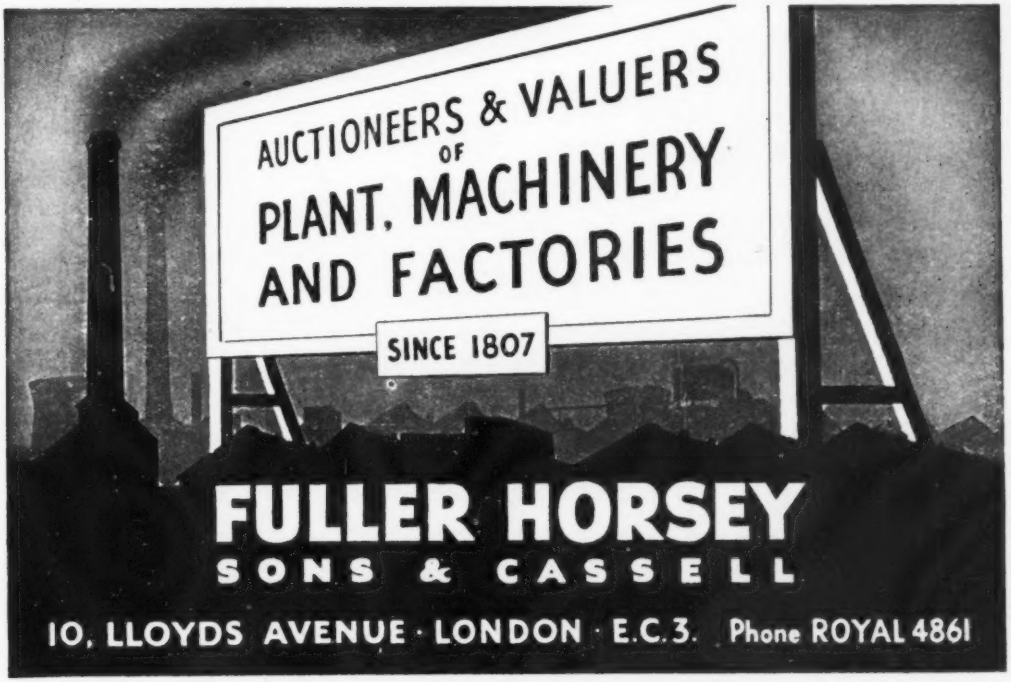

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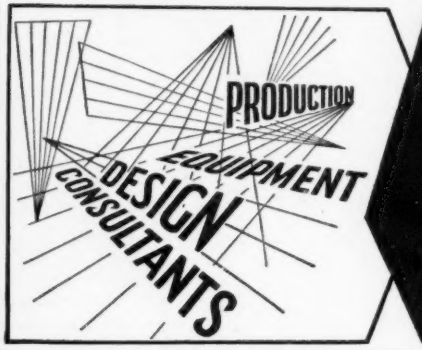


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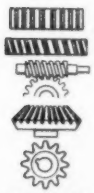

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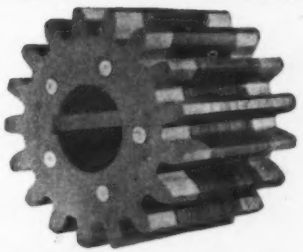

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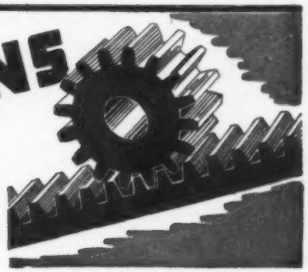

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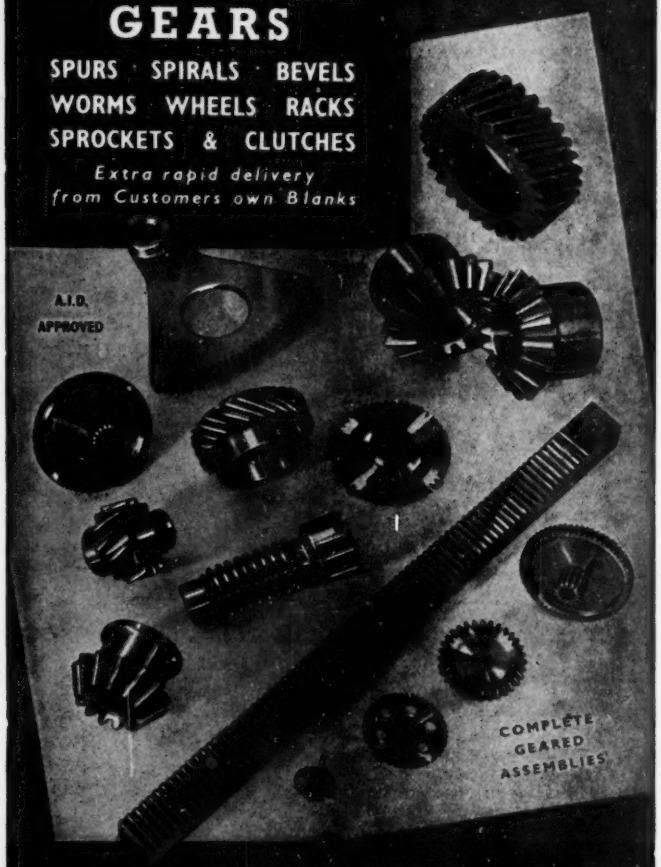


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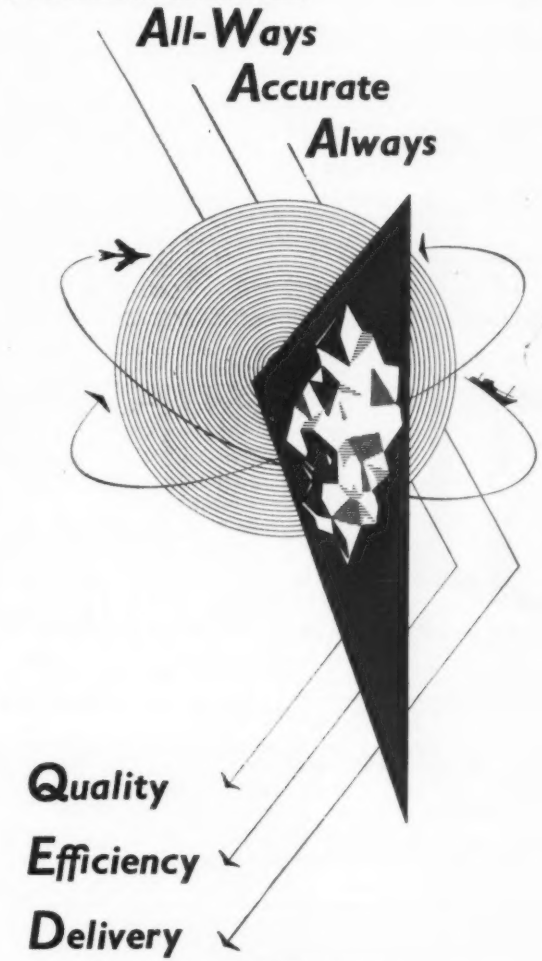


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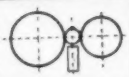
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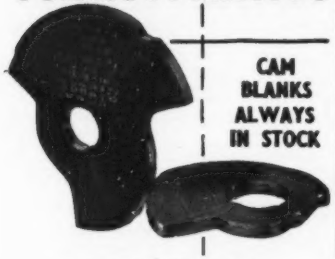
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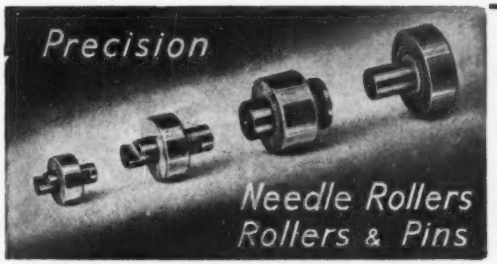


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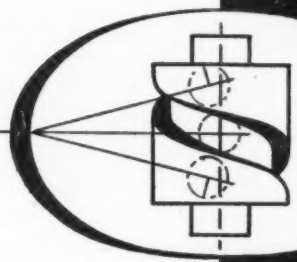

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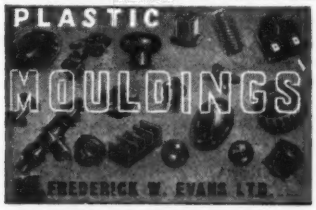


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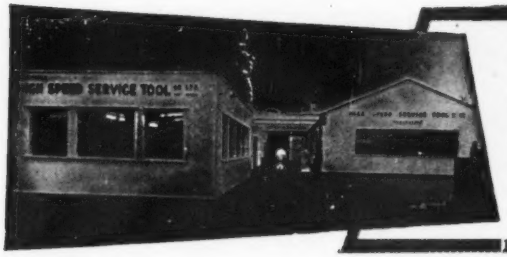

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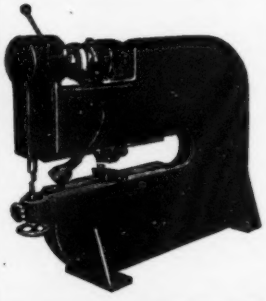

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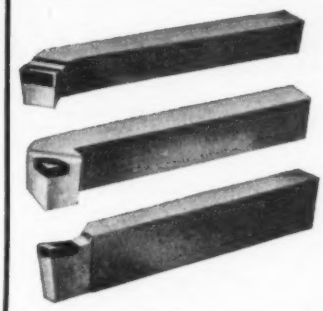
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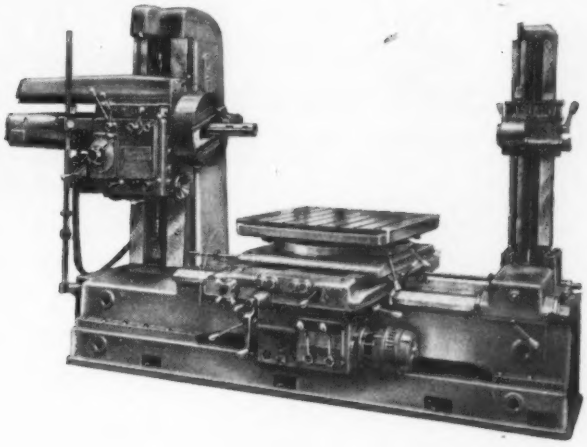

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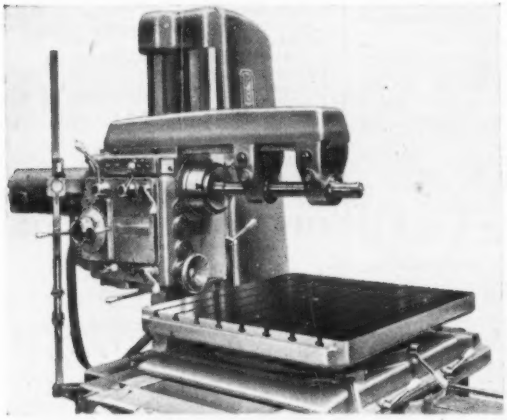

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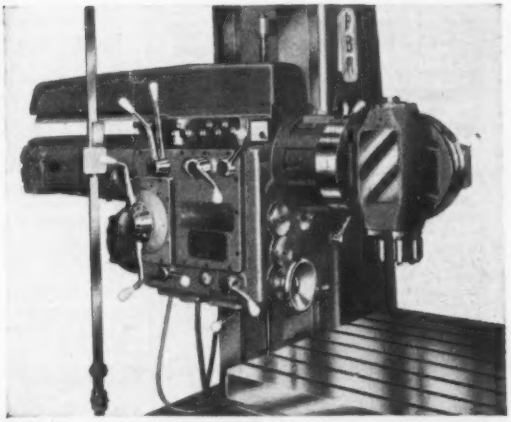


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**Churchill Hydraulic External** Grinders. Model A.Y. Capacity 6in. × 18in. Fully motorised.—WILCOX & CO., Barr Street, Birmingham 19. NORthern 1234/5.

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**Cunliffe & Croom Broaching** machine, 42in. pull, 2in. dia. screw. £200. —A. McNAMARA & CO., New Line, Bacup, Lancs. 'Phone: Bacup 946.

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**No. 4 Senior "Herbert"** "Eloptive" motorised Chucking Capstan Lathe with air chuck and chasing. Fismard bed. Max. swing over bed covers, 16¼in. dia. 8 spindle speeds, 125-1,500 r.p.m. Auto feed to saddle and cross-slide. New 1947.—LEE & HUNT, LTD., Crocus Street, Nottingham.

# SITUATIONS VACANT

*If you do not wish your reply to any Box No. advertisement in this section to be forwarded to certain firms, please advise us. Your reply will then be destroyed, but you will not be notified as this would disclose the identity of the advertiser.*

**General Manager for Engineers** in West London. Fully experienced in estimating, tooling and production of special-purpose machines. Sound practical engineer capable of taking full control of works up to 25 men, being directly responsible to Managing Director.—BOX Z224, MACHINERY, Clifton House, Euston Road, N.W.1.

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**Planning and Estimating Engineer** required by progressive precision engineering Company in Sussex manufacturing own specialised products.—Write giving full details of experience, age and present salary to BOX Z243, MACHINERY, Clifton House, Euston Road, N.W.1.

Classified Advertisements (*SITUATIONS VACANT, contd.*)

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**Production Controller Required** for modern factory, situated South West Essex, producing electrical mechanical assemblies. This is a senior position for a fully trained and experienced man who must also possess the drive and initiative necessary to maintain the flow of components to assembly stage. Successful applicant will receive a high remuneration and qualify for pension scheme.—Write stating age and particulars of previous employment.—BOX Z258, MACHINERY, Clifton House, Euston Road, N.W.1.

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**Representative, Experienced In** selling Machine Tools and with connections in London and Home Counties, required by London Firm. Good prospects for the right man.—Write in confidence, stating age and experience to: SALES MANAGER, BOX Z245, MACHINERY, Clifton House, Euston Road, N.W.1.

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require a

**REPRESENTATIVE**

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Seeks responsible interesting and active post.
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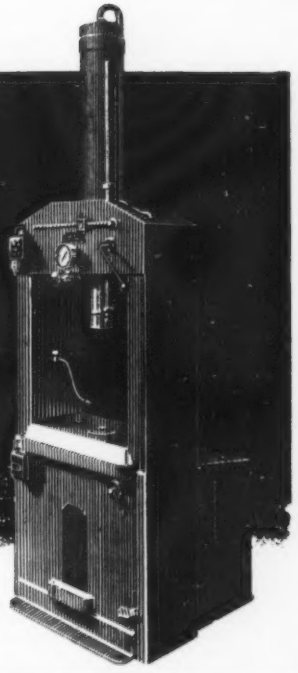

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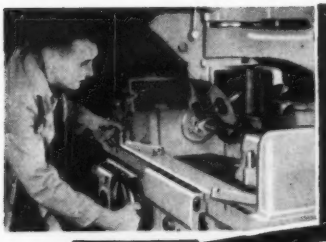
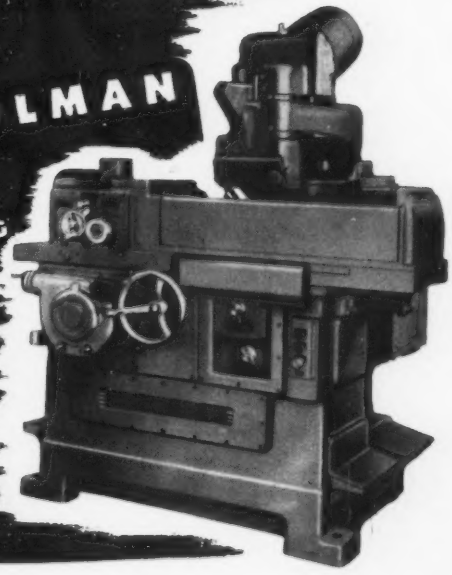


6-5 BARBER·COLMAN Hydraulic HOB SHARPENING MACHINE



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